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PHOTOSYNTHESIS AND RESPIRATION RATES IN THE MONTICELLO EXPERIMENTAL STREAMS: 1976/77 Diel Field Data and Computed Results

by

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16. ABSTRACT

Two-station diel dissolved oxygen measurements collected during 1976 and 1977 at the Monticello Ecological Research Station (Monticello, MN) have been analyzed by a graphical-analytical method and by a computer model, Dissolved Oxygen Routing Model (DORM), to determine daily community respiration and photosynthesis. A third set of values was generated by using the DORM model to simulate the graphical method. The complete DORM included surface oxygen exchange, longitudinal dispersion, a higher order curve extrapolation between upstream dissolved oxygen measurements and the dependence of respiratory rate on water temperature and dissolved oxygen measurements and the dependence of respiratory rate on water temperature and dissolved oxygen concentration, but neither the graphical nor the simulated graphical models included these factors. The complete DORM gave consistently higher rates of respiration and photosynthesis than either the graphical-analytical method or the computer simulation.

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SECTION 2

RESULTS AND CONCLUSIONS

Two methods of diel D.O. curve analysis were used to determine total daily community respiration (R) and photosynthesis (P) rates in the MERS field channels. The first is a graphical-analytical method described by Mattke and Stefan (1980). The second uses a computer model DORM (Dissolved Oxygen Routing Model) which solves the unsteady advective, dispersive, D.O. transport equation for P & R values as discussed by Gulliver, Mattke, and Stefan (1980). DORM may also be used to simulate the graphical method by assuming zero surface oxygen exchange, zero dispersion, and no temperature or D.O. dependence of respiration.

Tables 1a and 1b give the best estimates of total daily rates of photosynthesis and total daily rates of respiration obtained by either of the two methods. To arrive at the values in Table 1a, adjustments of partial daily rates to total daily rates had to be made. The procedure is described in Section 4.

For three surveys (8-23-77, 4-25-77, and 4-26-77) respiration and photosynthesis rates were calculated by three different methods: (a) the graphical-analytical method, (b) the numerical routing method DORM, and (c) a numerical simulation of the graphical-analytical method with DORM. The results are given in Table 7.

The complete routing (DORM) gave consistently higher rates of R and P than the graphical method. This is due to the omission of reaeration (surface oxygen exchange) in the graphical method. Based on Table 7 values, the effect of reaeration on P and R is channel position dependent, at least in spring and late summer. In the winter, reaeration effects may be the same throughout the channel because of low respiration rates.

Total daily rates of respiration and total daily rates of photosynthesis obtained by the graphical method were consistently smaller than

TABLE 1a. BEST ESTIMATES OF TOTAL DAILY RATES OF PHOTOSYNTHESIS ($g\ m^{-2}\ day^{-1}$)

Date / Station Nos.	Channel Nos. 1	4	5	8
7-28-76				
6 → 10	12.83	18.89	16.52	10.12
14 → 18	9.41	14.54	13.78	10.81
7-29-76				
6 → 10	20.23	16.81	18.21	10.09
14 → 18	11.70	16.63	13.07	13.19
8-5-76				
6 → 10	7.46	7.84	9.06	17.01
14 → 18	11.64	3.48	7.04	13.43
10-27-76				
2 → 10			3.20	4.81
10 → 18			3.86	6.36
10-28-76				
2 → 10			3.11	4.55
10 → 18			4.21	6.35
1-26-77				
2 → 10				8.46
10 → 18				6.48
1-27-77				
2 → 10				8.26
10 → 18				7.23
4-25-77				
2 → 10			5.77*	11.88*
10 → 18			7.48*	12.09*
4-26-77				
2 → 10			5.97*	12.79*
10 → 18			9.14*	13.20*
7-19-77				
2 → 10	18.76		19.81	11.79
10 → 18	11.06		15.07	17.94
7-20-77				
2 → 10	12.45		13.10	6.25
10 → 18	7.39		12.22	11.41
8-23-77				
2 → 10			10.96*	9.73*
10 → 18			10.37*	13.13*

*P-values determined by numerical routing with DORM (see Table 7). All others are obtained by the graphical method and adjusted.

TABLE 1b. BEST ESTIMATES OF TOTAL DAILY RATES OF RESPIRATION ($g\ m^{-2}\ day^{-1}$)

Date / Station Nos.	1	4	5	8
7-28-76				
6 → 10	19.45	17.99	19.45	17.54
10 → 14	15.47	19.03	20.58	18.88
8-5-76				
6 → 10	24.56	9.21	9.21	22.22
10 → 14	22.13	11.29	8.36	10.67
10-27-76				
2 → 10			3.47	10.88
10 → 18			4.21	8.30
1-26-77				
2 → 10			1.13	4.13
10 → 18			--	4.09
4-25-77				
2 → 10			8.21*	16.50*
10 → 18			9.98*	12.75*
4-26-77				
2 → 10			8.65*	17.28*
10 → 18			10.81*	13.75*
7-19-77				
2 → 10	17.99		20.97	17.43
10 → 18	12.24		19.86	18.96
8-23-77				
2 → 10			10.54*	14.36*
10 → 18			10.08*	14.35*

*R-values determined by numerical routing with DORM. All other obtained by the graphical method.

NOTE: Unstarred values were derived from Table 3 values as follows:

$$R(g\ m^{-2}\ day^{-1}) = \frac{R(g\ m^{-3}\ hr^{-1}) * (24\ hrs/day) * h(m)}{(reaeration\ adjustment)},$$

where $R(g\ m^{-3}\ hr^{-1})$ = respiration rate, obtained by graphical method and given in Table 3

$h(m)$ = hydraulic mean depth given in Appendix C

reaeration adjustment (accounts for omission of reaeration in graphical method)

= 0.87 for upper channel reaches

= 0.76 for lower channel reaches

those obtained by the DORM. The average fractions were 87 per cent and 89 per cent, respectively, for the upper channel reach (Stations 2-10) and 76 per cent and 81 per cent, respectively, for the lower channel reach (10-18). The results of the graphical method (Tables 3 and 6) were divided by these fractions to obtain the value in Tables 1a and 1b.

A sensitivity analysis was conducted to determine how rates of photosynthesis and respiration change in response to changes in residence time. This was of particular interest because information on channel cross sections was very incomplete. It was found that P and R rates go up as residence time goes up, and vice versa (Table 8). The relationship is nonlinear; for a +20 per cent change in residence time, R changed from +1.7 per cent to 11.0 per cent; for a -20 per cent change in residence time, R changed between -2.3 per cent to -9.6 per cent. The associated rate changes for photosynthesis (P) are +2.9 per cent to +13.6 per cent and -2.6 per cent to -12.7 per cent. For an unknown reason, this result is different from that found by Gulliver et al. (1980). Gulliver et al. (1980) found consistently a change of 17 to 18 per cent in total daily R and total daily P when residence times were changed by 20 per cent.

SECTION 3

RECOMMENDATIONS

It is recommended that in future studies using diel dissolved oxygen routing, particular care be taken to measure channel cross sections and flow rates or hydraulic residence time directly by tracer routing.

Application of a constant correction coefficient to the results of the graphical method implies that reaeration effects are of the same magnitude in spring, summer and fall. It is believed that this is not an unreasonable assumption, which has been verified at least for spring and late summer data. Application of the numerical method DORM would eliminate the assumption.

SECTION 4

APPLICATION OF A GRAPHICAL-ANALYTICAL PROCEDURE FOR STREAM PRODUCTIVITY ANALYSIS

GENERAL PROCEDURE

During 1976 and 1977 two-station diel D.O. measurements were taken by D. Rastetter of the Monticello Ecological Research Station staff. The data were made available to the authors for analysis. The data are reproduced in Appendix A.

To estimate the rates of community photosynthesis P (g m^{-2} day^{-1}) and the rates of community respiration R from the D.O. measurements a graphical-analytical routing method which is described by Mattke and Stefan (1980) was used. The method includes the following steps:

> After calculating the hydraulic residence time in a channel reach, the upstream station diel oxygen curve with the residence time added to the D.O. measurement time is plotted on the same graph with the downstream station diel oxygen curve. The difference in D.O. during night hours divided by the residence time yields an hourly nighttime respiration rate. All nighttime respiration rates are averaged and used as an estimate of the respiration rate that occurred during daylight hours. The photosynthetic rate is graphically determined by measuring the D.O. difference each hour during daylight. Each value is divided by the residence time to give an hourly rate; adding the average respiration rates gives an hourly photosynthetic rate (g m^{-3} hr^{-1}). The photosynthetic rates in g m^{-3} hr^{-1} were multiplied by the hydraulic mean depth to produce photosynthetic rates per unit surface area in g m^{-2} hr^{-1}. Addition of all hourly photosynthetic rates (g m^{-2} hr^{-1}) yielded an accumulated rate for the period of record.

Tables and graphs used in the actual computations are reproduced in Appendix B.

Residence Times

Residence times computed from 1976 and 1977 morphological channel data and temperature front data are summarized in Table 2. Residence

TABLE 2. CHANNEL SEGMENTS AND RESIDENCE TIMES FOR 1976-77 DIEL D.O. CURVE ANALYSIS

Survey Period Hours & Date	Channel Nos. 1	3	4	5	6	7	8
0515 7/28/76 to 2115 7/29/76	6→10[1] 2.22[2]	*	6→10[1] 2.16[2]	6→10[1] 2.16[2]	*	*	6→10[1] 2.16[2]
	14→18 2.22		14→18 2.16	14→18 2.16			14→18 2.16
1300 8/5/76 to 0920 8/6/76	6→10 1.37	*	6→10 1.37	6→10 1.32	*	*	6→10 1.37
	14→18 1.37		14→18 1.37	14→18 1.32			14→18 1.37
0640 10/27/76 to 1800 10/28/76	*	*	*	2→10 2.06	*	*	2→10 2.0[3]
				10→18 2.00			10→18 2.0[3]
0600 1/26/77 to 1730 1/27/77	*	*	*	2→10 2.06	*	*	2→10 2.0[3]
				10→18 2.00			10→18 2.0[3]
0400 4/25/77 to 1620 4/26/77	*	*	*	2→10 2.06	*	*	2→10 2.0[3]
				10→18 2.00			10→18 2.0[3]
0500 7/19/77 to 1700 7/20/77	2→10 2.04	**	*	2→10 2.06	*	**	2→10 2.0[3]
	10→18 1.78			10→18 2.00			10→18 2.0[3]
0500 8/23/77 to 0500 8/24/77	*	**	*	2→10 2.06	*	**	2→10 2.00[3]
				10→18 2.00			10→18 2.00[3]

* No D.O. data taken.

** D.O. data taken, but channel segment residence time was too large for diel D.O. curve analysis.

[1] Channel Reach, Station numbers.

[2] Hydraulic Residence Time (hrs).

[3] Hydraulic Residence Times determined by temperature fronts.

times for 7-28 and 7-29-76, 8-5-76, and 10-27 and 10-28-76 were computed between stations 6 and 10 and stations 14 and 18. However, residence times for 10-27 and 10-28-76, 1-26 and 1-27-77, 4-25 and 4-26-77, 7-19 and 7-20-77, and 8-23-77 were computed between stations 2 and 10 and stations 10 and 18 to obtain longer residence times for the diel curve analysis. On 7-19 and 7-20-77 and 8-23-77 a low flow rate in channel 3 resulted in unreasonably high residence times for the analysis.

Determination of hydraulic mean residence times presented difficulty because morphological channel data were incomplete. Channel cross section data were obtained on 8-4 and 8-5-77 in channels 5 and 8, on 4-6-77 in channel 1, and on 10-4 and 10-18-76 for channel 1. The average cross-sectional areas and flow rates were used to compute the residence time for each reach. The 8-4 and 8-5-77 calculated residence times were 2.06 hours and 2.00 hours in channel 5 and 1.65 hours and 1.64 hours in channel 8 for the upper and lower reach, respectively. These residence times were initially applied to the 7-19 and 7-20-77 and 8-23-77 D.O. survey dates.

No morphological data in channels 5 and 8 were taken in the spring and winter of 1977 and fall of 1976. However, areal cross sections and surface widths were determined for channel 1 on 4-6-77. These channel characteristics were used for channels 5 and 8 on 4-25-77 and gave a better estimate than the July or August channel data because of the increased water elevations due to macrophyte growth.

The 10-4 and 10-18-76 channel 1 morphometric survey was used to compute the residence times for the 7-28 and 7-29-76 and 8-5-76 D.O. measurements. Channel riffles were measured on 10-4-76 and channel pool sections on 10-18-76 and compiled to obtain a complete channel survey. The channel 1 data were applied to channels 4, 5, and 8 for residence time computations and are listed on Table 2.

The residence times calculated from the 8-4 and 8-5-77 and 4-6-77 morphological channel data were compared with residence times obtained by routing temperature discontinuities. Power failures produced temperature fronts in channel 8 before and after the 8-23-77 D.O. survey (see Figs. 1 and 2). Because channel 5 was not heated, there were no temperature fronts which could be used to estimate residence times. In this case the residence times computed from the 8-4 and 8-5-77 cross section surveys were assumed

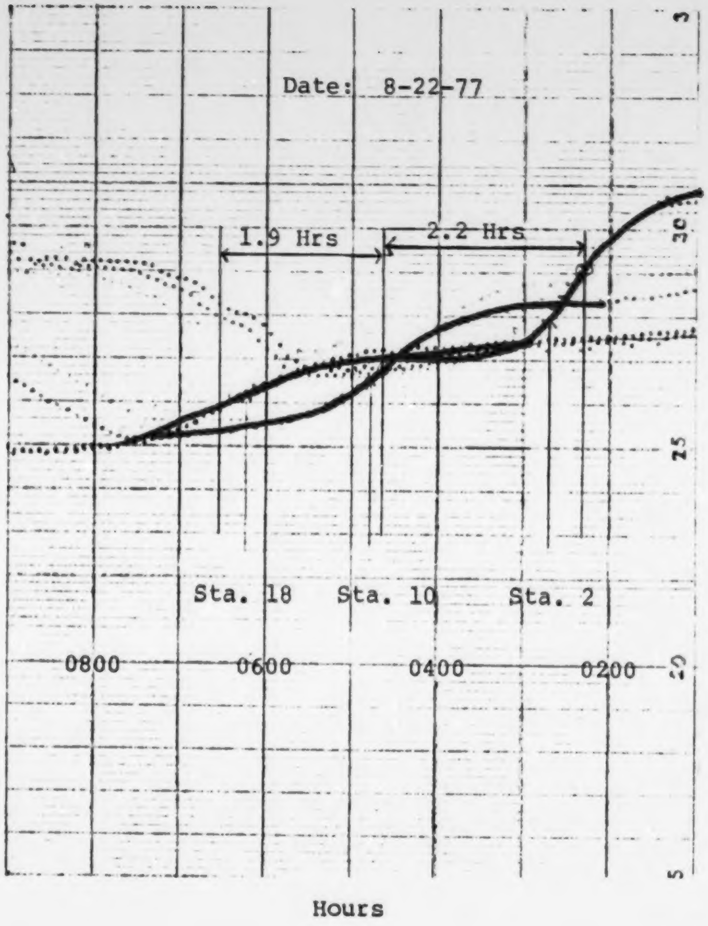

Fig. 1. Residence time determination from a temperature front on 8-22-77 between Stations 2 and 10 and Stations 10 and 18 in Channel 8.

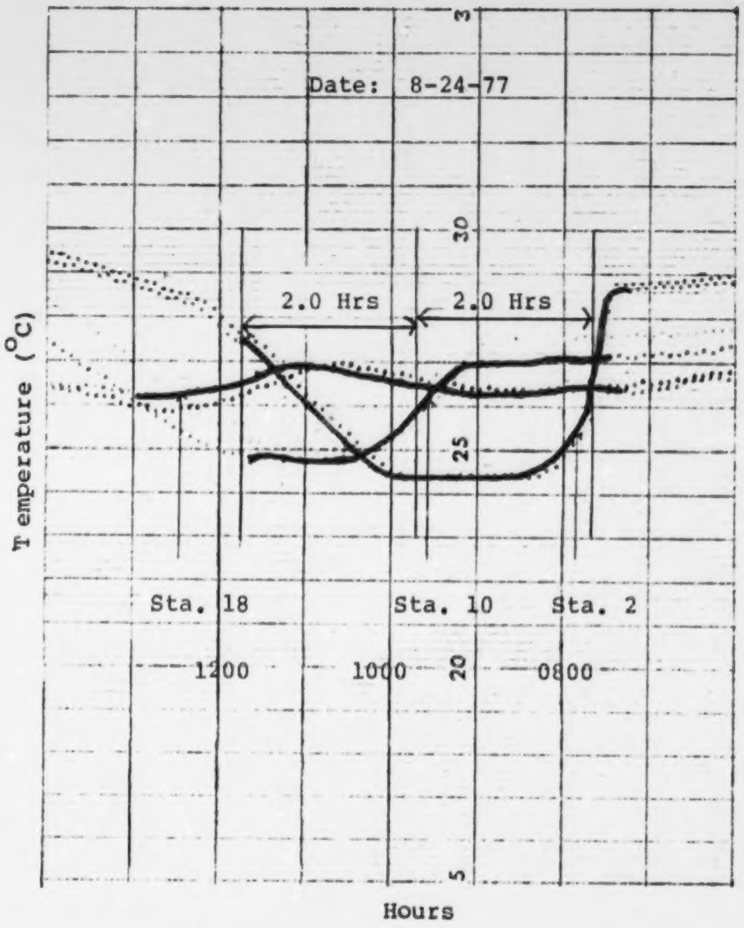

Fig. 2. Residence time determination from a temperature front on 8-24-77 between Stations 2 and 10 and Stations 10 and 18 in Channel 8.

correct for channel 5 because they were the same as the temperature front residence times in channel 8.

The application of channel 1 cross sections to channels 5 and 8 was tested by comparing a 4-19-77 channel 8 temperature front to the 4-6-77 channel 1 cross sections. The upper reach residence time determined by the temperature front, shown in Fig. 3, agreed with that determined from channel 1 morphological data which was 2 hours. The downstream channel 8 temperature front does not give as precise residence time resolution but is at least 2 hours. The lower reach channel 1 data residence time was 1.64 hours, which is at least 18 per cent lower than the temperature front residence time. It was assumed that the lower reach travel time was the same as the upper reach travel time of 2 hours, which was used in the graphical analysis for 4-25 and 4-26-77, 1-26 and 1-27-77, and 10-27 and 10-28-77. Table 2 summarizes and lists the best estimates of channel residence times determinated by morphological or temperature front data.

Only the starting time and the end time of each D.O. sampling interval in the MERS channels had been recorded. It was therefore necessary to estimate the actual time at which a D.O. sample was taken from a particular station. Knowledge of the sampling sequence in which stations along the channels were sampled permitted estimates of actual D.O. measurement times. Knowing the length of a survey and the number of stations sampled, it was determined that it took approximately 3 minutes to collect each D.O. sample and to travel to the next station. Therefore, 3 minutes were added to the sampling time of each station in the order sampled. The D.O. measurements along with the estimated time are shown in Appendix A.

Rates of Community Respiration & Photosynthesis

Respiration Rates

Several difficulties were encountered in the determination of community respiration and photosynthesis rates as explained and discussed in the paragraphs that follow.

The July 28 and 29, 1976, respiration rates were difficult to evaluate because of the lack of D.O. data during the night. As shown on the graphs for 7-28 and 7-29-76 in Appendix B, linear interpolation between late evening and early morning D.O. reading resulted in unreasonably high respiration rates. In view of this problem, the oxygen curves were

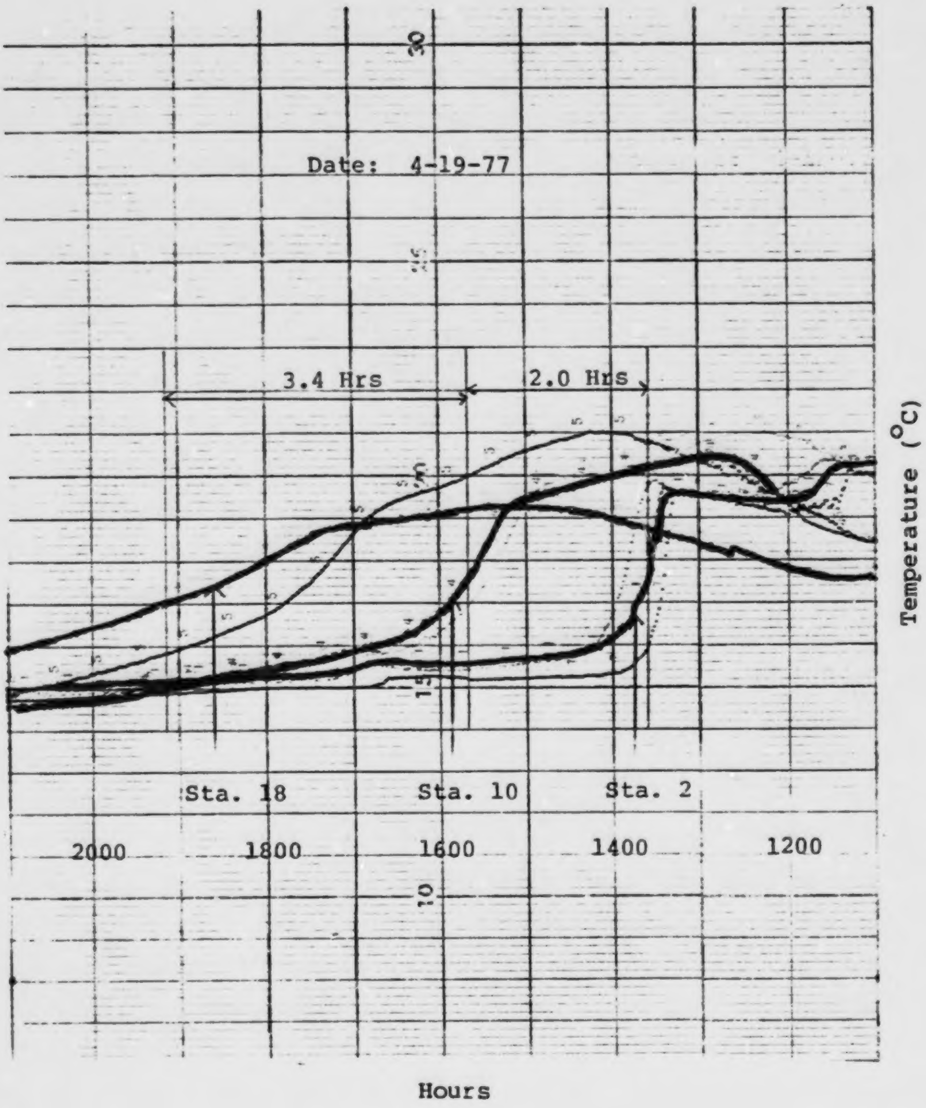

Fig. 3. Residence time determination from a temperature front on 4-19-77 between stations 2 and 10 and Stations 10 and 18 in Channel 8.

evaluated only to the point where the actual D.O. readings ended. When the computed residence time was obviously incorrect or when no D.O. measurements had been taken during the night, the respiration rate for the reach upstream or downstream was used. This problem only occurred on 7-28-76 in channels 4 and 5 between stations 6 and 10 as indicated in Table 3.

At low D.O. concentrations respiration may be reduced. When D.O. concentration fell below 3 mg/ℓ during the night, a respiration rate limitation was anticipated. This data was therefore not used in determining an average respiration rate. Date restrictions for this method of analysis are footnoted in Table 3.

Photosynthetic Rates

When morphological channel residence time underestimated temperature front residence time (channel 8), the surveyed cross-sectional areas were adjusted in proportion to the difference in residence times. It was assumed that the surface width remained the same in spite of the areal increase because of the steep channel slopes. The hydraulic mean depth for each reach was determined using the newly computed cross sections divided by the known surface width. This hydraulic mean depth was multiplied by the volumetric photosynthetic rate (g m^{-3} hr^{-1}) to yield a photosynthetic rate (g m^{-2} hr^{-1}) per unit surface area. The daily community photosynthetic rates derived from the given D.O. data are presented in Table 4. Difficulties encountered during the analysis are identified.

A problem arose from incomplete D.O. measurements, not covering all of the daylight hours. The computed daily photosynthetic rates were therefore partial rates and had to be multiplied by a coefficient to obtain total daily photosynthetic rates. The coefficient was derived (Table 5) by determining the fraction of total hourly photosynthetic rates that the missing daylight hours represented. This was accomplished by determining fractions of total daily photosynthesis from complete data sets obtained on other survey days. The complete data sets were chosen on the basis of similarity of light intensity and length of day. The fractioning process is designed to account for changes in light intensity over a day, and to account for differences in total daily radiation between the dates which are being compared. Three days (from which the coefficients were derived) were chosen

TABLE 3. HOURLY RESPIRATION RATES FROM GRAPHICAL-ANALYTICAL PROCEDURE

($g\ m^{-3}\ hr^{-1}$)

Date / Station Nos.	Channel Nos. 1	4	5	8
7-28-76				
6 → 10	1.33 a	1.23 b, e	1.33 b, e	1.20 a
14 → 18	1.00 a	1.23	1.33 a	1.22 a
8-5-76				
6 → 10	1.68	0.63	0.63	1.52 c
14 → 18	1.43 c	0.73 c	0.54 c	0.69 c
10-27-76				
2 → 10			0.37	1.16
10 → 18			0.37	0.73
1-26-77				
2 → 10			0.12 d	0.44
10 → 18			d	0.36
4-25-77				
2 → 10			0.84	1.72
10 → 18			0.84	0.92
7-19-77				
2 → 10	1.63		2.00	1.58
10 → 18	1.02		1.70	1.58 c
8-23-77				
2 → 10			1.06	1.39
10 → 18			0.86	1.59 c

a - Used only ΔD.O. after sunset + lag time to determine respiration value.

b - Lag seems to be incorrect and no D.O. data readings during the evening. Used computed downstream respiration value.

c - D.O. values below 3 mg/ℓ were not used in calculating respiration.

d - ΔD.O. too small to make meaningful analysis.

e - Lag time appears to be incorrect (started 2300 Hr in calculating R-value)

TABLE 4. PARTIAL DAILY RATES OF COMMUNITY PHOTOSYNTHESIS FROM GRAPHICAL-ANALYTICAL PROCEDURE ($g\ m^{-2}\ day^{-1}$)

Date / Station Nos.	Channel Nos. 1	4	5	8
7-28-76				
6 → 10	11.13 a_2	16.38 a_2, d	14.33 a_2, d	8.49 a_3
14 → 18	6.79 a_4	11.48 a_2	10.88 a_2	8.54 a_2
7-29-76				
6 → 10	18.01	14.96 d	16.21 a	8.75 a_2
14 → 18	9.48 c, d	13.47	10.32 a_2	9.51 a_4
8-5-76				
6 → 10	2.90 a_9	3.05 a_9	3.52 a_9	6.61 a_9
14 → 18	4.11 a_9	1.23 a_9	2.49 a_9	4.75 a_9
10-27-76				
2 → 10			2.85	4.28
10 → 18			3.10 a_1	5.15
10-28-76				
2 → 10			2.25 b_2	4.05
10 → 18			3.41	5.14
1-26-77				
2 → 10			0.01 e	7.53
10 → 18			-- e	5.25
1-27-77				
2 → 10			-- e	7.35
10 → 18			-- e	5.86
4-25-77				
2 → 10			4.55	10.09
10 → 18			5.21	8.18
4-26-77				
2 → 10			4.03 b_3	8.90 b_3
10 → 18			5.38 b_3	7.82 b_3
7-19-77				
2 → 10	16.57 a_1		17.49	10.41 a_1
10 → 18	8.89 a_1		12.11	14.16 a_2
7-20-77				
2 → 10	8.92 b_3		7.77 b_5	4.48 b_3
10 → 18	4.82 b_3		7.97 b_3	7.44 b_3
8-23-77				
2 → 10			9.59 a_1	8.17 a_1
10 → 18			7.42 a_1	11.06 a_1

a_N - Missing hours from sunrise where N indicates number of hours missing, i.e. a_4 implies first 4 consecutive hours after sunrise.
b_N - Missing hours before sunset where N indicates number of hours missing, i.e. b_2 implies last 2 hours before sunset are missing.
c - Negative photosynthetic rate value occurred before sunset so this value was not included in accumulated photosynthetic rate.
d - Residence time seems incorrect.
e - ΔD.O. too small to make meaningful analysis.
NOTE: Hydraulic mean depths are given in appendix C.

TABLE 5. COEFFICIENTS TO ADJUST PARTIAL DAILY RATES OF PHOTOSYNTHESIS TO TOTAL DAILY RATES OF PHOTOSYNTHESIS

Date Coeff. Was Derived For:	Date Coeff. Was Derived From:	Hours Missing After Sunrise					Hours Missing Before Sunset		
		1 Hr	2 Hr	3 Hr	4 Hr	9 Hr	2 Hr	3 Hr	5 Hr
		Coefficients							
7/28-29/76 7/19-20/77 8/ 5/76	7/31/79	1.008	1.026	1.061	1.123	2.290		1.242	1.501
10-27-76	10-8-78	1.010					1.233		
4-26-77	4-25-77							1.120	
8-23-77	8-1-79	1.022							

Example: The 4-26-77 coefficient was derived from the 4-25-77 survey as shown in Appendix D.

from Mattke and Stefan (1980) while the fourth day in April was selected prior to the day with missing data as shown in Table 5. Table 6 presents the corrected total daily photosynthetic rates. (For example, the adjusted photsynthetic rate for channel 8 on 8/23/77 for Stations 2 to 10 is 8.17x1.022 = 8.35.)

TABLE 6. TOTAL DAILY RATES OF COMMUNITY PHOTOSYNTHESIS FROM GRAPHICAL-ANALYTICAL PROCEDURE WITHOUT REAERATION ADJUSTMENT ($g\ m^{-2}\ day^{-1}$)

Date / Station Nos.	Channel Nos. 1	4	5	8
7-28-76				
6 → 10	11.42 a_2	16.81 a_2, d	14.70 a_2, d	9.01 a_3
14 → 18	7.62 a_4	11.78 a_2	11.16 a_2	8.76 a_2
7-29-76				
6 → 10	18.01	14.96 d	16.21 d	8.98 a_2
14 → 18	9.48 c, d	13.47	10.59 a_2	10.68 a_4
8-5-76				
6 → 10	6.64 a_9	6.98 a_9	8.06 a_9	15.14 a_9
14 → 18	9.43 a_9	2.82 a_9	5.70 a_9	10.88 a_9
10-27-76				
2 → 10			2.85	4.28
10 → 18			3.13 a_1	5.15
10-28-76				
2 → 10			2.77 b_2	4.05
10 → 18			3.41	5.14
1-26-77				
2 → 10			-- e	7.53
10 → 18			-- e	5.25
1-27-77				
2 → 10			-- e	7.35
10 → 18			-- e	5.86
4-25-77				
2 → 10			4.55	10.09
10 → 18			5.21	8.18
4-26-78				
2 → 10			4.50 b_3	9.97 b_3
10 → 18			6.03 b_3	8.76 b_3
7-19-77				
2 → 10	16.70 a_1		17.63	10.49 a_1
10 → 18	8.96 a_1		12.21	14.53 a_1
7-20-77				
2 → 10	11.08 b_3		11.66 b_5	5.56 b_3
10 → 18	5.99 b_3		9.90 b_3	9.24 b_3
8-23-77				
2 → 10			9.80 a_1	8.35 a_1
10 → 18			7.58 a_1	11.30 a_1

a_N - Missing hours from sunrise where N indicates number of hours missing, i.e. a_4 implies first 4 consecutive hours after sunrise.

b_N - Missing hours before sunset where N indicates number of hours missing, i.e., b_2 implies last 2 hours before sunset are missing.

c - Negative photosynthetic rate value occurred before sunset, so this value was not included in accumulated photosynthetic rate.

d - Residence time seems incorrect.

e - ΔD.O. too small to make meaningful analysis

NOTE: Hydraulic mean depths are given in Appendix C.

SECTION 5

APPLICATION OF THE NUMERICAL DISSOLVED OXYGEN ROUTING METHOD (DORM) FOR STREAM PRODUCTIVITY ANALYSIS

A numerical Dissolved Oxygen Routing Model (DORM) was developed by Gulliver, Mattke, and Stefan (1980) to determine total stream community photosynthesis and respiration rates through successive routing of two-station diel D.O. measurements. The model includes surface oxygen exchange, longitudinal dispersion, a higher order curve extrapolation between upstream D.O. measurements, and dependence of respiratory rate on water temperature and D.O. concentration.

The graphical-analytical procedure can also be simulated by DORM numerically. This is accomplished by making the same assumptions as in the graphical method; namely,no surface oxygen exchange (reaeration) or longitudinal dispersion occurs, respiration is independent of temperature and D.O. concentration, and a linear interpolation between D.O. measurements is used. DORM used in this manner will be referred to as "graphical DORM" as opposed to the "complete DORM."

Two D.O. survey dates were selected (8-23-77 and 4-25-77) for complete DORM and graphical DORM analysis. These dates were used to investigate the seasonal effect of surface exchange on photosynthesis and respiration rates. All input parameters needed for DORM were readily available except for appropriate channel cross sections. As previously discussed, when morphological channel characteristics underestimated temperature front residence times, the cross sections were increased in proportion to the difference in their residence times.

Table 7 compares results from the complete DORM, the graphical DORM, and the true graphical procedure for daily community respiration and photosynthetic rates. As before, incomplete D.O. measurements taken during the day resulted in partial photosynthetic rates. These values

TABLE 7. TOTAL AND PARTIAL DAILY COMMUNITY RESPIRATION AND PHOTOSYNTHESIS RATES FOR COMPLETE DORM, GRAPHICAL DORM, AND THE GRAPHICAL-ANALYTICAL METHOD (UNADJUSTED FOR MISSING DAYLIGHT HOURS)

Date	Channel	Segment	Respiration g m^{-2} day^{-1}			Photosynthesis g m^{-2} day^{-1}			% Graphical DORM R-Value Is of Complete DORM	% Graphical DORM P-Value Is of Complete DORM
			Complete DORM	Graphical DORM	Graphical	Complete DORM	Graphical DORM	Graphical		
8-23-77	5	2 10	10.54	8.78	9.36 a_1	10.72	9.41	9.59 a_1	83	88
8-23-77	5	10 18	10.08	7.55	7.25 a_1	10.15	8.03	7.42 a_1	75	79
8-23-77	8	2 10	14.36	13.27	12.79 a_1	9.52	8.55	8.17 a_1	92	90
8-23-77	8	10 18	14.35	11.63	13.90 a_1	12.85	10.81	11.06 a_1	81	84
4-25-77	5	2 10	8.21	7.45	6.85	5.77	5.14	4.55	91	89
4-25-77	5	10 18	9.98	8.04	7.26	7.48	5.95	5.21	81	80
4-25-77	8	2 10	16.50	14.59	14.04	11.88	10.61	10.09	88	89
4-25-77	8	10 18	12.75	9.44	7.95	12.09	9.68	8.18	74	80
4-26-77	5	2 10	8.65	7.45	6.85 b_3	5.33	4.71	4.03 b_3	86	88
4-26-77	5	10 18	10.81	8.04	7.26 b_3	8.16	6.77	5.38 b_3	74	83
4-26-77	8	2 10	17.28	14.59	14.04 b_3	11.42	10.17	8.90 b_3	84	89
4-26-77	8	10 18	13.75	9.44	7.95 b_3	11.79	9.55	7.82 b_3	69	81

a_1 indicates 1 hour of D.O. measurements were missing before sunrise.

b_3 indicates 3 hours of D.O. measurements were missing before sunset.

were multiplied by the coefficients in Table 5 to obtain the total daily photosynthetic rates listed in Table 8.

When comparing the graphical DORM and complete DORM, assuming a small temperature change between the upstream and downstream reaches, the D.O. saturation concentrations can be considered approximately the same. The lower the measured D.O. falls below the D.O. saturation concentration, the greater the oxygen influx from surface exchange. As a control volume travels downstream, respiration occurs, which lowers the D.O. concentration in that control volume. Thus, surface exchange should increase downstream. The higher surface exchange becomes, the higher the respiration rate must become to account for this increased oxygen input into the system. The graphical methods with and without DORM will underestimate P and R downstream due to the increased extent of surface oxygen exchange.

TABLE 8. TOTAL DAILY RATES OF PHOTOSYNTHESIS FROM DORM ($g\ m^{-2}\ day^{-1}$)

Date / Station Nos.	Channel Nos. 1	4	5	8
4-25-77				
2 → 10			5.77	11.88
10 → 18			7.48	12.09
4-26-77				
2 → 10			5.97*	12.79*
10 → 18			9.14	13.20
8-23-77				
2 → 10			10.96*	9.73*
10 → 18			10.37*	13.13*

*Photosynthetic rates adjusted from complete DORM for missing daylight hours.

SECTION 6

RESIDENCE TIME SENSITIVITY ANALYSIS

Gulliver et al. (1980) found total daily community photosynthesis and respiration rates very sensitive to the hydraulic residence time. Thus, a sensitivity analysis was conducted with DORM to investigate the influence of residence time on respiration and photosynthetic rates.

The residence time was increased and decreased by 20 per cent by increasing and decreasing the cross-sectional area by 20 per cent. The channel surface width was not altered in order to provide a constant surface area for surface exchange. A 20 per cent error margin for residence time was used for a variety of reasons. As discussed previously, residence time computed from channel cross sections was 18 per cent lower than found by temperature fronts. Also, a 3 to 5 per cent error is possible in the actual flow rate measurements at MERS. Also variation in water depth due to macrophyte growth is observed at a constant flow rate.

The results of the residence time sensitivity analysis are shown in Table 9.

TABLE 9. RESIDENCE TIME SENSITIVITY ANALYSIS

Date	Channel	Segment	Respiration g m^{-2} day^{-1}			Photosynthesis g m^{-2} day^{-1}			% Difference			
									Respiration		Photosynthesis	
			Complete DORM	20% Increase	20% Decrease	Complete DORM	20% Increase	20% Decrease	Increase	Decrease	Increase	Decrease
8-23-77	5	2 10	10.54	11.18	9.94	10.71	11.50	10.03	6.1	-5.7	7.4	-6.3
8-23-77	5	10 18	10.08	11.19	9.11	10.15	11.53	8.86	11.0	-9.6	13.6	-12.7
8-23-77	8	2 10	14.36	14.86	13.93	9.53	10.03	9.08	3.5	-3.0	5.4	-4.6
8-23-77	8	10 18	14.35	15.03	13.72	12.85	13.62	12.11	4.7	-4.4	6.0	-5.8
4-25-77	5	2 10	8.21	8.49	7.89	5.78	6.01	5.43	3.4	-3.9	4.0	-6.0
4-25-77	5	10 18	9.98	10.50	9.50	7.48	8.06	6.94	5.2	-4.8	7.8	-7.2
4-25-77	8	2 10	16.50	16.79	16.12	11.88	12.22	11.57	1.8	-2.3	2.9	-2.6
4-25-77	8	10 18	12.75	13.57	12.01	12.09	12.95	11.29	6.4	-5.8	7.1	-6.6
4-26-77	5	2 10	8.66	8.95	8.32	5.33	5.65	5.01	3.3	-3.9	6.0	-6.0
4-26-77	5	10 18	10.81	11.37	10.27	8.16	8.85	7.52	5.2	-5.00	8.5	-7.8
4-26-77	8	2 10	17.28	17.58	16.88	11.42	11.81	11.02	1.7	-2.3	3.4	-3.5
4-26-77	8	10 18	13.75	14.64	12.95	11.79	12.82	10.82	6.5	-5.8	8.7	-8.2

BIBLIOGRAPHY

Gulliver, John S, Mattke, Tedd, W., and Stefan, Heinz G., 1980. "Numerical and Graphical Procedures for Estimation of Community Photosynthesis and Respiration in experimental Streams," St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Project Report No. 198, 123 pp.

Gulliver, John S. and Stefan, Heinz G., 1981. "Air-Water Oxygen Exchange: Theory and Application to Experimental Streams," St. Anthony Falls Hydraulic Laboratory, University of Minnesota, External Memorandum No. M-173, 108 pp.

Hahn, M., Gulliver, and Stefan, H. G., 1978. "Physical Characteristics of the Experimental Field Channels at the USEPA Ecological Research Station in Monticello, Minnesota," University of Minnesota, St. Anthony Falls Hydraulic Laboratory, External Memorandum No. M-156, 36 pp.

Mattke, Tedd W. and Stefan, Heinz G., 1980. "Graphical Method to Estimate Stream Community Respiration and Primary Productivity from Dissolved Oxygen Measurements," University of Minnesota, St. Anthony Falls Hydraulic Laboratory, External Memorandum No. M-169, 53 pp.

APPENDIX A

SUMMARY OF DIEL DISSOLVED OXYGEN DATA

PROVIDED BY MERS

Format: 12F5.2, F5.2, 19
Data, Station #, Channel #, Date

The first two lines give the values of the measured D.O. (g/m^3) and the following two lines give the time (hrs) (after 0:00 hr of the first day) corresponding to each D.O. measurement.

	Data	Sta-tion	Chan-nel	Date
D.O. (g/m^3)	4.60 4.70 5.25 5.70 6.40 6.85 7.20 7.20 6.60 4.35 5.00 4.10	2.0	8	7-28-76
D.O. (g/m^3)	6.50 6.15 7.50 7.35 7.30 6.60 0 0 0 0 0 0	2.0	8	7-28-76
Time (hr)	5.18 7.18 9.1811.1813.1815.1817.1819.1821.1829.1831.1833.18	2.0	8	7-28-76
Time (hr)	35.1837.1839.1841.1843.1845.18 0 0 0 0 0 0	2.0	8	7-28-76
	2.50 3.05 4.20 5.70 6.00 6.75 7.35 6.60 4.60 2.70 3.10 2.95	4.0	8	7-28-76
	2.75 3.25 5.05 6.75 7.90 7.80 7.55 6.90 4.80 0 0 0	4.0	8	7-28-76
	5.21 7.21 9.2111.2113.2115.2117.2119.2121.2123.4825.4827.48	4.0	8	7-28-76
	29.2131.2133.2135.2137.2139.2141.2143.2145.21 0 0 0	4.0	8	7-28-76
	1.65 2.50 4.55 6.35 7.50 8.30 8.80 7.25 4.15 1.80 2.60 5.60	6.0	8	7-28-76
	7.95 9.8010.10 9.25 6.25 4.35 0 0 0 0 0 0	6.0	8	7-28-76
	5.24 7.24 9.2411.2413.2415.2417.2419.2421.2429.2431.2433.24	6.0	8	7-28-76
	35.2437.2439.2441.2443.2445.24 0 0 0 0 0 0	6.0	8	7-28-76
	.20 .35 2.70 5.10 7.10 7.75 8.95 8.10 4.55 1.55 .30 .40	10.0	8	7-28-76
	.50 2.40 5.65 9.7010.6010.30 6.90 4.80 0 0 0 0	10.0	8	7-28-76
	5.27 7.27 9.2711.2713.2715.2717.2719.2721.2723.4525.4527.45	10.0	8	7-28-76
	31.2733.2735.2737.2739.2741.2743.2745.27 0 0 0 0	10.0	8	7-28-76
	.05 .65 4.30 7.0010.2011.5011.15 8.80 5.30 .10 3.65 8.15	14.0	8	7-28-76
	12.1512.6011.25 8.60 5.55 0 0 0 0 0 0 0	14.0	8	7-28-76
	5.30 7.30 9.3011.3013.3015.3017.3019.3021.3031.3933.3935.39	14.0	8	7-28-76
	37.3939.3941.3943.3945.39 0 0 0 0 0 0 0	14.0	8	7-28-76
	.30 2.50 5.05 8.2010.6011.4010.05 6.25 2.60 .20 .15 2.35	18.0	8	7-28-76
	6.3010.9012.6012.35 9.90 6.60 0 0 0 0 0 0	18.0	8	7-28-76
	7.33 9.3311.3313.3315.3317.3319.3321.3323.4225.4231.3333.33	18.0	8	7-28-76
	35.3337.3339.3341.3343.3345.33 0 0 0 0 0 0	18.0	8	7-28-76
	4.90 4.90 6.20 6.40 7.20 7.55 8.00 7.55 6.20 4.75 5.60 7.85	2.0	5	7-28-76
	8.05 8.70 7.95 5.20 0 0 0 0 0 0 0 0	2.0	5	7-28-76
	5.51 7.51 9.5111.5113.5115.5117.5119.5121.5129.5131.5135.51	2.0	5	7-28-76
	37.5139.5143.5145.51 0 0 0 0 0 0 0 0	2.0	5	7-28-76
	3.40 4.30 5.40 6.40 7.85 8.60 8.75 7.50 5.25 4.40 3.95 3.80	4.0	5	7-28-76
	3.40 4.60 8.45 9.80 9.35 7.10 5.40 0 0 0 0 0	4.0	5	7-28-76
	5.48 7.48 9.4811.4813.4815.4817.4819.4821.4823.2725.2727.27	4.0	5	7-28-76
	29.4831.4835.4837.4839.4843.4845.48 0 0 0 0 0	4.0	5	7-28-76
	2.85 4.00 5.80 7.40 8.8510.0010.15 8.25 5.10 2.90 4.10 9.40	6.0	5	7-28-76
	10.1511.4010.20 7.65 5.35 0 0 0 0 0 0 0	6.0	5	7-28-76
	5.45 7.45 9.4511.4513.4515.4517.4519.4521.4529.4531.4535.45	6.0	5	7-28-76
	37.4539.4541.4543.4545.45 0 0 0 0 0 0 0	6.0	5	7-28-76

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  1.90 2.70 5.40 6.80 9.2011.3011.9010.80 7.25 5.25 2.75 2.40 10.0  5  7-28-76
  2.15 2.80 8.2011.4013.2012.6510.20 7.15    0    0    0    0 10.0  5  7-28-76
  5.42 7.42 9.4211.4213.4215.4217.4219.4221.4223.3325.3327.33 10.0  5  7-28-76
 29.4231.4235.4237.4239.4241.4243.4245.42    0    0    0    0 10.0  5  7-28-76
  1.55 2.00 4.70 7.4010.5012.4013.0012.00 8.85 1.55 1.75 8.30 14.0  5  7-28-76
 13.0014.5513.6012.25 9.00    0    0    0    0    0    0    0 14.0  5  7-28-76
  5.39 7.39 9.3911.3913.3915.3917.3919.3921.3929.3931.3935.39 14.0  5  7-28-76
 37.3939.3941.3943.3945.39    0    0    0    0    0    0    0 14.0  5  7-28-76
  1.05 1.15 3.30 5.60 8.9011.5512.8511.95 9.45 6.25 3.40 1.90 18.0  5  7-28-76
   .90 1.05 6.00 9.9513.2514.2013.2510.60    0    0    0    0 18.0  5  7-28-76
  5.36 7.36 9.3611.3613.3615.3617.3619.3621.3623.3925.3927.39 18.0  5  7-28-76
 29.3631.3635.3637.3639.3641.3643.3645.36    0    0    0    0 18.0  5  7-28-76
  5.05 5.45 6.20 7.20 7.85 8.75 9.05 8.45 7.15 5.40 5.60 6.90  2.0  4  7-28-76
  7.80 8.75 9.10 9.20 8.45 7.20    0    0    0    0    0    0  2.0  4  7-28-76
  5.18 7.18 9.1811.1813.1815.1817.1819.1821.1829.1831.1833.18  2.0  4  7-28-76
 35.1837.1839.1841.1843.1845.18    0    0    0    0    0    0  2.0  4  7-28-76
  3.95 4.45 5.75 7.25 8.15 8.95 9.35 8.75 6.45 5.25 4.85 4.20  4.0  4  7-28-76
  4.25 4.65 6.60 8.20 9.1510.00 9.45 8.45 6.55    0    0    0  4.0  4  7-28-76
  5.21 7.21 9.2111.2113.2115.2117.2119.2121.2123.2425.2427.24  4.0  4  7-28-76
 29.2131.2133.2135.2137.2139.2141.2143.2145.21    0    0    0  4.0  4  7-28-76
  3.35 3.50 5.65 7.35 8.55 9.9510.55 9.35 6.40 3.45 3.90 6.25  6.0  4  7-28-76
  8.5510.8011.2511.00 9.25 6.60    0    0    0    0    0    0  6.0  4  7-28-76
  5.24 7.24 9.2411.2413.2415.2417.2419.2421.2429.2431.2433.24  6.0  4  7-28-76
 35.2437.2439.2441.2443.2445.24    0    0    0    0    0    0  6.0  4  7-28-76
  2.20 2.60 5.05 7.10 9.3010.9512.0011.10 7.75 4.85 3.05 4.60 10.0  4  7-28-76
  2.30 2.50 5.30 8.7511.6013.0513.3511.15 8.20    0    0    0 10.0  4  7-28-76
  5.27 7.25 9.2711.2713.2715.2717.2719.2721.2723.3025.3027.30 10.0  4  7-28-76
 29.2731.2733.2735.2737.2739.2741.2743.2745.27    0    0    0 10.0  4  7-28-76
  1.35 1.60 3.85 5.85 8.4010.3011.8511.60 9.45 1.40 1.65 3.95 14.0  4  7-28-76
  7.2510.7012.2012.4014.2510.00    0    0    0    0    0    0 14.0  4  7-28-76
  5.30 7.30 9.3011.3013.3015.3017.3019.3021.3029.3031.3033.30 14.0  4  7-28-76
 35.3037.3039.3041.3043.3045.30    0    0    0    0    0    0 14.0  4  7-28-76
  1.10 1.20 3.30 5.30 7.9510.1011.5011.20 9.25 7.15 4.40 2.55 18.0  4  7-28-76
  1.30 1.25 3.60 7.5510.0512.1513.4012.2510.60    0    0    0 18.0  4  7-28-76
  5.33 7.33 9.3311.3313.3315.3317.3319.3321.3323.3625.3627.36 18.0  4  7-28-76
 29.3331.3333.3335.3337.3339.3341.3343.3345.33    0    0    0 18.0  4  7-28-76
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 4.80 5.20 6.20 6.60 7.10 7.85 8.00 9.55 6.25 4.80 4.90 6.10  2.0  1  7-28-76
 7.05 7.75 8.00 8.20 7.55 7.00    0    0    0    0    0    0  2.0  1  7-28-76
 5.51 7.51 9.5111.5113.5115.5117.5119.5121.5129.5131.5133.51  2.0  1  7-28-76
35.5137.5139.5141.5143.5145.51    0    0    0    0    0    0  2.0  1  7-28-76
 2.40 3.30 4.35 5.25 5.90 6.50 6.50 5.60 4.55 4.95 3.45 3.20  4.0  1  7-28-76
 2.90 3.30 4.85 6.15 6.70 7.05 6.85 5.85 5.00    0    0    0  4.0  1  7-28-76
 5.48 7.48 9.4811.4813.4815.4817.4819.4821.4823.2125.2127.21  4.0  1  7-28-76
29.4831.4833.4835.4837.4839.4841.4843.4845.48    0    0    0  4.0  1  7-28-76
 1.45 1.80 3.00 3.60 4.55 5.20 5.40 4.80 3.20 1.85 2.00 3.30  6.0  1  7-28-76
 4.60 5.85 6.00 5.95 5.25 4.00    0    0    0    0    0    0  6.0  1  7-28-76
 5.45 7.45 9.4511.4513.4515.4517.4519.4521.4529.4531.4533.45  6.0  1  7-28-76
35.4537.4539.4541.4543.4545.45    0    0    0    0    0    0  6.0  1  7-28-76
 1.35 2.90 4.95 6.30 6.60 6.45 3.80 1.15  .60  .15  .65  .05 10.0  1  7-28-76
 3.60 6.40 8.95 8.90 7.40 1.95    0    0    0    0    0    0 10.0  1  7-28-76
 7.42 9.4211.4213.4215.4217.4219.4221.4223.1825.1827.1829.42 10.0  1  7-28-76
33.4235.4237.4239.4241.4245.42    0    0    0    0    0    0 10.0  1  7-28-76
  .75 4.50 6.40 8.65 9.95 9.65 7.00 1.75  .45 4.80 9.3012.10 14.0  1  7-28-76
12.2010.05 6.60 2.85    0    0    0    0    0    0    0    0 14.0  1  7-28-76
 7.35 9.3911.3913.3915.3917.3919.3921.3931.3933.3935.3937.39 14.0  1  7-28-76
39.3941.3943.3945.39    0    0    0    0    0    0    0    0 14.0  1  7-28-76
  .35 2.35 5.35 8.75 9.70 9.35 7.60 3.40  .60  .30 3.55 8.00 18.0  1  7-28-76
11.5011.5510.55 7.45 4.05    0    0    0    0    0    0    0 18.0  1  7-28-76
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5.24	7.21	9.24	11.24	13.24	15.24	17.24	19.24	21.24	23.24	25.24	27.24	18.0	8	8-23-77
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9.60	9.60	9.60	9.60	9.60	9.60	9.70	9.85	9.95	10.10	10.40	10.65	8.5	10-	8-78
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15.04	16.04	17.04	18.04	19.04	20.14	21.04	24.00	24.00	24.00	24.00	24.00	8.5	10-	8-78
9.00	9.00	9.00	9.00	9.00	9.10	9.35	9.70	10.05	10.30	10.55	10.70	15.5	10-	8-78
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2.26	3.26	4.26	5.26	6.26	8.08	9.08	10.08	11.08	12.08	13.08	14.08	15.5	10-	8-78
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 8.15 8.15 8.15 8.15 8.15 8.40 8.45 8.60 8.75 9.05 9.30 9.50  8.5  9-29-78
 9.50 9.40 9.10 9.00 8.80 8.60    0    0    0    0    0    0  8.5  9-29-78
 2.48 3.48 4.48 5.48 6.48 8.14 9.0410.0411.0412.0813.0415.29  8.5  9-29-78
16.0417.0418.0419.0420.0421.0424.0024.0024.0024.0024.0024.00  8.5  9-29-78
 7.85 7.85 7.85 7.85 7.85 8.10 8.35 8.50 8.75 9.05 9.25 9.60 11.5  9-29-78
 9.60 9.40 9.20 9.10 8.85 8.70    0    0    0    0    0    0 11.5  9-29-78
 2.45 3.45 4.45 5.45 6.45 8.16 9.0610.0611.0612.1013.0615.31 11.5  9-29-78
16.0617.0618.0619.0620.0621.0624.0024.0024.0024.0024.0024.00 11.5  9-29-78
 7.50 7.50 7.50 7.50 7.50 7.75 8.10 8.60 8.90 9.40 9.50 9.50 15.5  9-29-78
 9.45 9.25 9.00 8.70 8.35 8.15    0    0    0    0    0    0 15.5  9-29-78
 2.40 3.40 4.40 5.40 6.40 8.18 9.0810.0811.0812.1213.0815.33 15.5  9-29-78
16.0817.0818.0819.0820.0821.0824.0024.0024.0024.0024.0024.00 15.5  9-29-78
 7.30 7.30 7.30 7.30 7.30 7.60 8.00 8.50 9.00 9.45 9.80 9.70 17.5  9-29-78
 9.65 9.30 8.95 8.60 8.25 8.00   -0   -0   -0   -0   -0   -0 17.5  9-29-78
 2.37 3.37 4.37 5.37 6.37 8.21 9.1110.1211.0912.1613.1015.35 17.5  9-29-78
16.1017.0918.0919.1020.1021.1024.0024.0024.0024.0024.0024.00 17.5  9-29-78
 8.15 8.15 8.15 8.15 8.15 8.20 8.20 8.25 8.50 8.60 8.75 8.80  6.5  9-20-78
 9.05 9.05 9.00 8.90 8.70 8.60 8.40   -0   -0   -0   -0   -0  6.5  9-20-78
 1.56 2.56 3.56 4.56 5.56 7.05 8.02 9.0210.0211.0212.0213.02  6.5  9-20-78
14.0215.0917.0218.0219.0220.5424.0024.0024.0024.0024.0024.00  6.5  9-20-78
 8.00 8.00 8.00 8.00 8.00 8.00 8.10 8.20 8.40 8.55 8.75 8.85  8.5  9-20-78
 9.10 9.15 9.10 9.00 8.70 8.55 8.25   -0   -0   -0   -0   -0  8.5  9-20-78
 1.58 2.58 3.58 4.58 5.58 8.04 9.0310.0311.0312.0313.0314.04  8.5  9-20-78
15.1116.0417.0418.0419.0420.0520.5724.0024.0024.0024.0024.00  8.5  9-20-78
 7.60 7.60 7.60 7.60 7.60 7.65 7.70 7.85 8.05 8.15 8.45 8.65 11.5  9-20-78
 8.95 9.10 9.10 9.00 8.85 8.50 8.25 7.95   -0   -0   -0   -0 11.5  9-20-78
 2.02 3.02 4.02 5.02 6.02 7.07 8.06 9.0410.0411.0512.0413.04 11.5  9-20-78
14.0615.1316.0617.0618.0619.0620.0821.0024.0024.0024.0024.00 11.5  9-20-78
```

7.05	7.05	7.05	7.05	7.05	7.10	7.20	7.40	7.75	8.00	8.30	8.65	15.5	9-20-78
8.95	9.20	9.25	9.15	8.90	8.45	8.00	7.75	-0	-0	-0	-0	15.5	9-20-78
2.10	3.10	4.10	5.10	6.10	7.08	8.08	9.05	10.05	11.06	12.05	13.05	15.5	9-20-78
14.08	15.15	16.08	17.08	18.08	19.08	20.12	21.03	24.00	24.00	24.00	24.00	15.5	9-20-78
6.80	6.80	6.80	6.80	6.80	6.85	7.00	7.20	7.50	7.90	8.30	8.65	17.5	9-20-78
9.10	9.15	9.30	9.20	8.95	8.50	8.00	7.65	-0	-0	-0	-0	17.5	9-20-78
2.14	3.14	4.14	5.14	6.14	7.09	8.10	9.07	10.07	11.09	12.07	13.08	17.5	9-20-78
14.10	15.19	16.11	17.11	18.11	19.11	20.16	21.05	24.00	24.00	24.00	24.00	17.5	9-20-78
7.50	7.50	7.50	7.50	7.50	7.55	7.60	7.60	7.75	7.80	7.80	7.70	-2.5	9-13-78
7.70	7.05	6.35	0	0	0	0	0	0	0	0	0	-2.5	9-13-78
2.59	3.59	4.59	5.59	6.59	8.00	9.00	10.00	11.00	12.05	13.00	16.02	-2.5	9-13-78
19.00	21.00	22.02	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	-2.5	9-13-78
7.05	7.05	7.05	7.05	7.05	7.20	7.20	7.25	7.30	7.40	7.45	7.50	6.5	9-13-78
7.00	6.80	7.60	7.20	6.65	7.30	6.35	6.55	5.90	0	0	0	6.5	9-13-78
2.04	3.04	4.04	5.04	6.04	7.00	8.02	9.02	10.01	11.02	12.07	13.02	6.5	9-13-78
14.02	15.02	16.03	17.01	18.07	19.02	20.04	21.04	22.05	24.00	24.00	24.00	6.5	9-13-78
6.85	6.85	6.85	6.85	6.85	6.95	6.95	7.00	7.00	7.10	7.30	7.30	8.5	9-13-78
7.45	7.45	6.60	6.25	0	0	0	0	0	0	0	0	8.5	9-13-78
2.07	3.07	4.07	5.07	6.07	7.02	8.04	9.04	10.03	11.04	12.09	13.04	8.5	9-13-78
16.03	19.04	21.06	22.08	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	8.5	9-13-78
6.35	6.35	6.35	6.35	6.35	6.50	6.50	6.60	6.70	6.85	7.10	7.15	11.5	9-13-78
7.25	6.90	6.80	6.30	6.10	6.05	0	0	0	0	0	0	11.5	9-13-78
2.11	3.11	4.11	5.11	6.11	7.04	8.06	9.06	10.04	11.06	12.11	13.06	11.5	9-13-78
16.07	18.11	19.07	20.10	21.09	22.11	24.00	24.00	24.00	24.00	24.00	24.00	11.5	9-13-78
5.75	5.75	5.75	5.75	5.75	5.95	6.00	6.00	6.15	6.30	6.60	6.75	15.5	9-13-78
7.00	6.55	6.55	6.05	0	0	0	0	0	0	0	0	15.5	9-13-78
2.17	3.17	4.17	5.17	6.17	7.05	8.08	9.08	10.06	11.08	12.13	13.08	15.5	9-13-78
16.09	18.13	19.09	21.11	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	15.5	9-13-78
5.40	5.40	5.40	5.40	5.40	5.65	5.70	5.90	6.20	6.50	6.65	6.90	17.5	9-13-78
6.70	6.45	6.25	6.20	0	0	0	0	0	0	0	0	17.5	9-13-78
2.19	3.19	4.19	5.19	6.19	7.06	8.10	10.07	11.10	12.15	13.10	16.10	17.5	9-13-78
17.08	18.15	19.12	21.15	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	17.5	9-13-78
6.40	6.40	6.40	6.40	6.40	6.70	6.70	6.80	6.85	6.95	7.05	7.10	2.5	9-11-78
7.10	7.10	7.15	7.10	7.00	6.90	0	0	0	0	0	0	2.5	9-11-78
2.39	3.39	4.39	5.39	6.39	7.00	8.00	9.00	10.00	12.00	13.00	14.00	2.5	9-11-78
15.05	16.05	17.03	18.05	19.02	21.05	24.00	24.00	24.00	24.00	24.00	24.00	2.5	9-11-78

```
 6.10 6.10 6.10 6.10 6.10 6.20 6.30 6.50 6.65 6.80 6.95 6.95  6.5  9-11-78
 7.00 7.15 7.10 6.95 6.90 6.70 6.60    0    0    0    0    0  6.5  9-11-78
 2.31 3.31 4.31 5.31 6.31 7.02 9.0210.0211.0212.0213.0214.02  6.5  9-11-78
15.0716.0717.0518.0819.0420.0721.0724.0024.0024.0024.0024.00  6.5  9-11-78
 5.85 5.85 5.85 5.85 5.85 5.90 5.95 6.00 6.20 6.50 6.70 6.80  8.5  9-11-78
 6.95 7.15 7.25 7.20 7.00 6.80 6.55 6.50    0    0    0    0  8.5  9-11-78
 2.23 3.23 4.23 5.23 6.23 7.04 8.04 9.0410.0411.0412.0413.04  8.5  9-11-78
14.0415.0916.0917.0718.1119.0620.0921.0924.0024.0024.0024.00  8.5  9-11-78
 5.30 5.30 5.30 5.30 5.30 5.40 5.50 5.90 6.65 6.70 6.75 7.25 11.5  9-11-78
 7.30 7.30 7.20 6.85 6.45 5.95 5.60    0    0    0    0    0 11.5  9-11-78
 2.17 3.17 4.17 5.17 6.17 7.06 8.06 9.0611.0612.0613.0614.06 11.5  9-11-78
15.1116.1117.0918.1419.0820.1121.1124.0024.0024.0024.0024.00 11.5  9-11-78
 4.55 4.55 4.55 4.55 4.55 4.55 4.85 5.40 6.00 6.55 6.90 6.90 15.5  9-11-78
 7.55 7.80 7.80 7.50 6.85 6.40 5.65 5.15    0    0    0    0 15.5  9-11-78
 2.14 3.14 4.14 5.14 6.14 7.08 8.08 9.0810.0811.0812.0813.08 15.5  9-11-78
14.0815.1316.1317.1118.1719.1020.1321.1424.0024.0024.0024.00 15.5  9-11-78
 4.05 4.05 4.05 4.05 4.05 4.15 4.40 5.15 6.00 6.40 7.00 6.95 17.5  9-11-78
 7.55 7.80 7.80 7.60 7.00 6.40 5.45 4.85    0    0    0    0 17.5  9-11-78
 2.11 3.11 4.11 5.11 6.11 7.10 8.10 9.1010.1011.1012.1013.10 17.5  9-11-78
14.1015.1516.1517.1518.1919.1220.1521.1824.0024.0024.0024.00 17.5  9-11-78
 7.05 7.05 7.05 7.05 7.05 7.20 7.30 7.40 7.55 7.50 7.50 7.50  2.5  9- 5-78
 7.40 7.00 6.75 6.30   -0   -0   -0   -0   -0   -0   -0   -0  2.5  9- 5-78
 2.02 3.02 4.02 5.02 6.02 7.17 8.0210.0212.0213.0214.0215.02  2.5  9- 5-78
17.0918.0619.0220.0824.0024.0024.0024.0024.0024.0024.0024.00  2.5  9- 5-78
 5.70 5.70 5.70 5.70 5.70 5.80 6.30 6.40 6.60 7.00 7.20 7.25 10.5  9- 5-78
 7.15 7.00 6.75 6.30   -0   -0   -0   -0   -0   -0   -0   -0 10.5  9- 5-78
 2.04 3.04 4.04 5.04 6.04 7.1910.0411.0412.0413.0414.0416.04 10.5  9- 5-78
17.1118.0819.0420.1224.0024.0024.0024.0024.0024.0024.0024.00 10.5  9- 5-78
 4.80 4.80 4.80 4.80 4.80 4.90 5.25 5.65 6.40 6.55 7.20 7.30 15.5  9- 5-78
 7.60 7.60 7.70 7.45 6.90 6.45 5.50    0    0    0    0    0 15.5  9- 5-78
 2.06 3.06 4.06 5.06 6.06 7.21 8.06 9.0610.0611.0612.0613.06 15.5  9- 5-78
14.0615.0616.0617.1418.0919.0720.1624.0024.0024.0024.0024.00 15.5  9- 5-78
 4.20 4.20 4.20 4.20 4.20 4.30 4.60 5.25 6.10 6.90 7.35 7.90 19.5  9- 5-78
 8.05 8.20 7.85 7.30 6.50 5.70    0    0    0    0    0    0 19.5  9- 5-78
 2.08 3.08 4.08 5.08 6.08 7.23 8.08 9.0810.0811.0812.0813.08 19.5  9- 5-78
14.0816.0817.1618.1119.0920.1824.0024.0024.0024.0024.0024.00 19.5  9- 5-78
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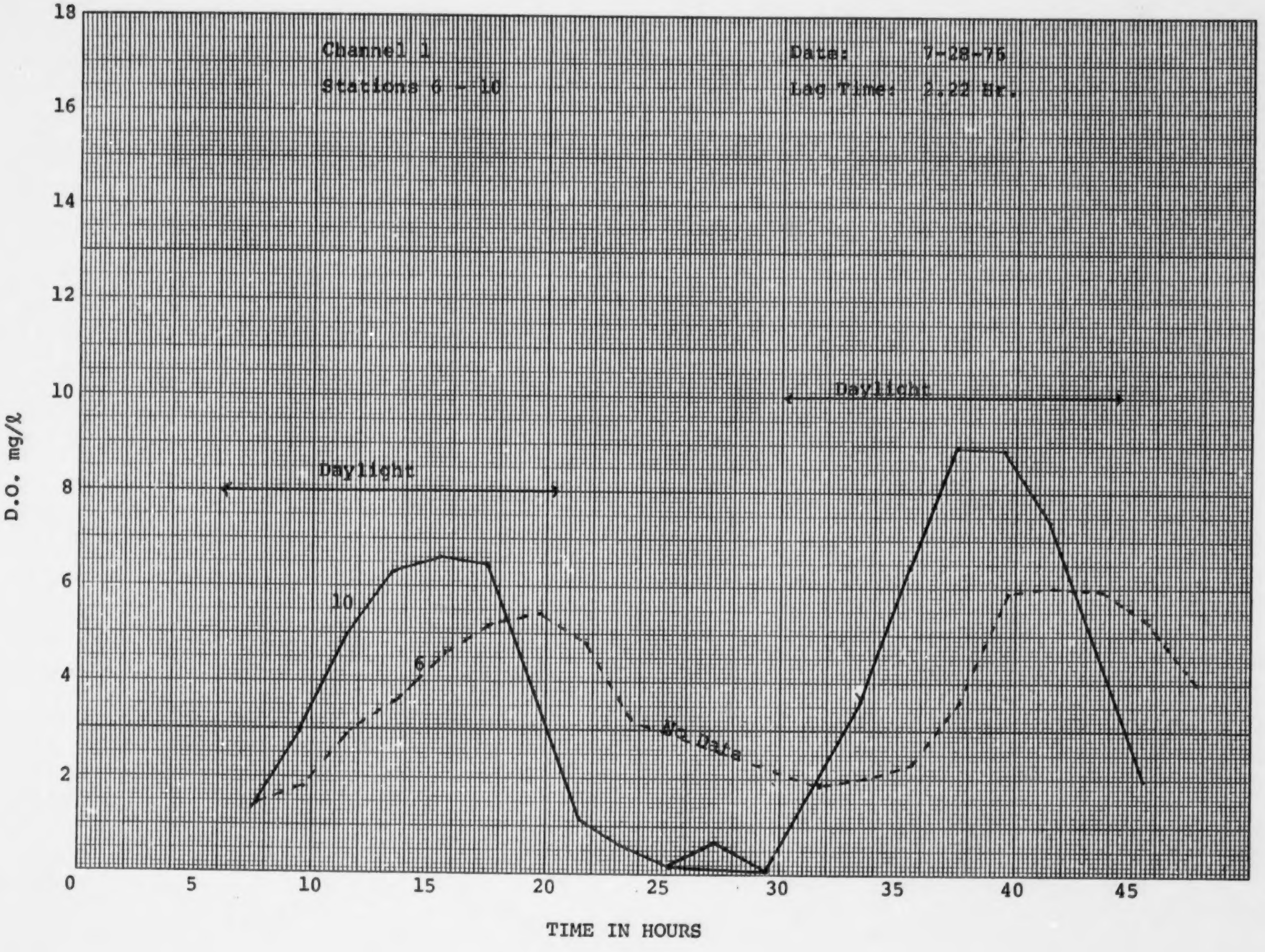
APPENDIX B

TABULAR AND GRAPHICAL ANALYSIS OF TWO-STATION DIEL DISSOLVED OXYGEN DATA

(Procedure described in University of Minnesota St. Anthony Falls Hydraulic Laboratory Project Report No. 198, June, 1981 and External Memorandum M-169, Dec. 1980.)



Channel 1
Stations 6 - 10
Date: 7-28-76
Lag Time: 2.22 Hr.
Daylight
Daylight
10
6
No Data
D.O. mg/ℓ
TIME IN HOURS
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45

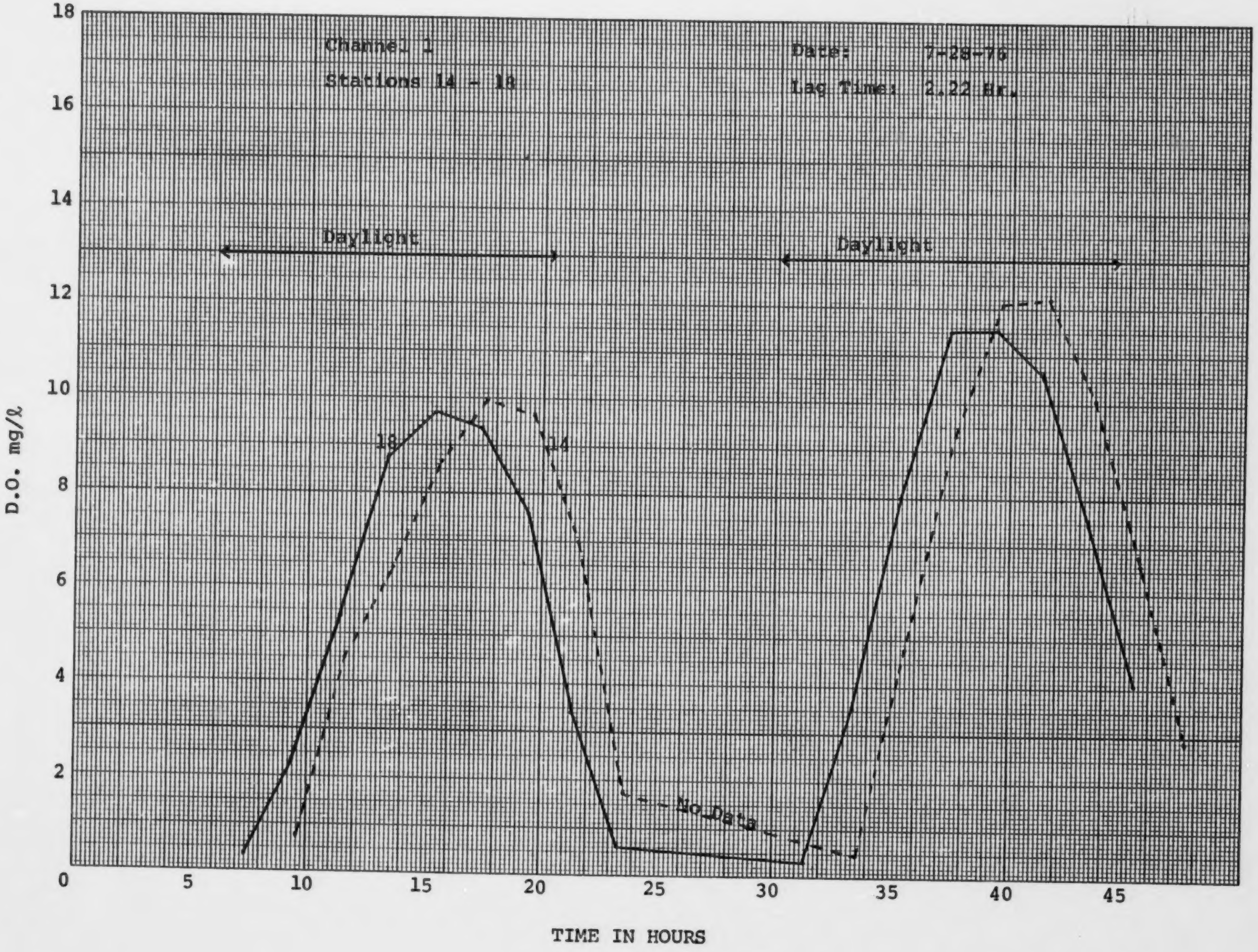
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 6 to 10 in Channel 1

Date: 7-28-76 | Travel Time: 2.22 Hrs

Time at Downstream Station (hrs)	R g m^{-3} hr^{-1}	ΔD.O. g m^{-3}	ΔD.O. g m^{-3} hr^{-1}	P g m^{-3} hr^{-1}	P g m^{-2} hr^{-1}	Comments
0000 **						1. Error in Station 10
0100						D.O. data.
0200						2. Only one hour was
0300						used to compute
0400						respiration rate,
0500						due to lack of D.O.
0600						data.
0700						
0800	1.33	0.12	0.05	1.38	0.73	
0900		0.40	0.18	1.51	0.80	
1000		0.66	0.30	1.63	0.86	
1100		0.86	0.39	1.72	0.91	
1200		1.01	0.46	1.78	0.94	
1300		1.17	0.53	1.86	0.99	
1400		1.19	0.54	1.87	0.99	
1500		1.04	0.47	1.80	0.95	
1600		0.85	0.38	1.71	0.91	
1700		0.68	0.31	1.64	0.87	
1800		0.21	0.10	1.42	0.75	
1900		-0.43	-0.19	1.14	0.60	
2000		-0.90	-0.40	0.92	0.49	
2100	1.33	-1.51	-0.68	0.65	0.34	
2200		-3.56				
2300	1.33					
2400					$\Sigma P = 11.13$ g m^{-2} day^{-1}	
2500						
2600					$\bar{R} = 1.33$ g m^{-3} hr^{-1}	
2700						
2800						
2900						
3000	1.33	0.59	0.27	1.60	0.85	
3100		1.06	0.48	1.81	0.96	
3200		1.49	0.67	2.00	1.06	
3300		1.85	0.83	2.16	1.14	
3400		2.32	1.04	2.37	1.26	
3500		2.89	1.30	2.63	1.39	
3600		3.34	1.50	2.83	1.50	
3700		3.62	1.63	2.96	1.57	
3800		3.51	1.58	2.91	1.54	
3900		2.98	1.34	2.67	1.42	
4000		2.44	1.10	2.43	1.29	
4100		2.07	0.93	2.26	1.20	
4200		1.56	0.70	2.03	1.08	
4300		0.96	0.43	1.76	0.93	
4400	1.33	0.48	0.22	1.55	0.82	
4500	D.O. Data Ended					
4600						
4700					$\Sigma P = 18.01$ g m^{-2} day^{-1}	

**Daylight savings time.


Channel 1
Stations 14 - 18
Date: 7-28-76
Lag Time: 2.22 Hr.
Daylight
Daylight
18
14
No Data
D.O. mg/ℓ
0
2
4
6
8
10
12
14
16
18
0
5
10
15
20
25
30
35
40
45
TIME IN HOURS

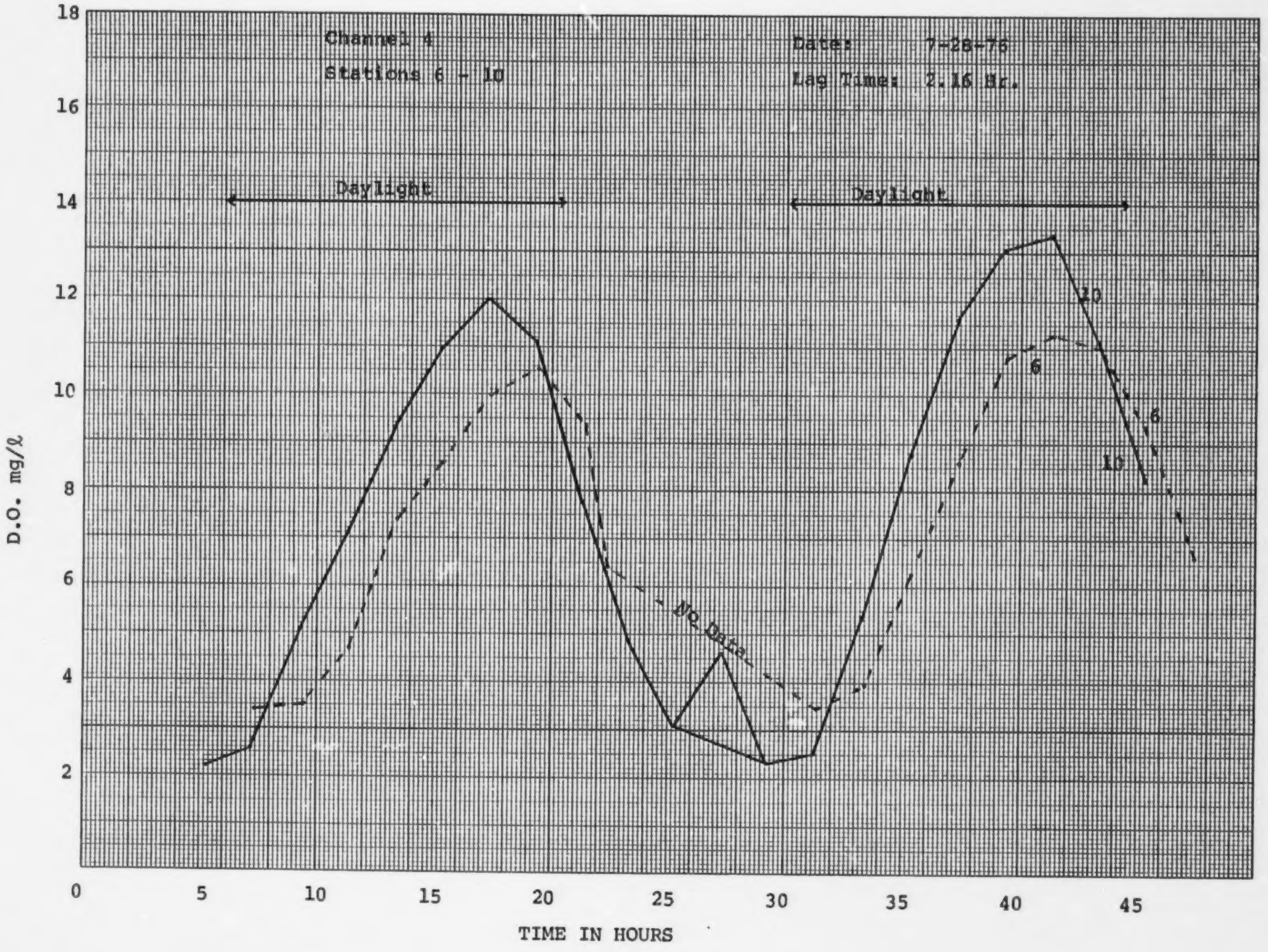
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 14 to 18 in Channel 1

Date: 7-28-76 Travel Time: 2.22 Hrs

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						Only one hour was used to
0100						compute respiration rate
0200						due to lack of D.O. data.
0300						
0400						
0500						
0600						
0700						
0800						
0900						
1000	1.00	1.80	0.81	1.81	0.89	
1100		1.42	0.64	1.64	0.80	
1200		1.54	0.69	1.69	0.83	
1300		2.29	1.03	2.03	0.99	
1400		2.20	0.99	1.99	0.98	
1500		1.56	0.70	1.70	0.83	
1600		0.72	0.32	1.32	0.65	
1700		-0.13	-0.06	0.94	0.46	
1800		-1.05	-0.47	0.53	0.26	
1900		-1.75	-0.79	0.21	0.10	
2000	1.00	-2.80	-1.26			
2100						
2200						
2300	1.00					
2400						$\Sigma P = 6.79\ g\ m^{-2}\ day^{-1}$
2500						
2600						$\bar{R} = 1.00\ g\ m^{-3}\ hr^{-1}$
2700						
2800						
2900						
3000	1.00	-0.57	-0.26	0.74	0.36	
3100		-0.48	0.22	0.78	0.38	
3200		0.62	0.28	1.28	0.63	
3300		3.41	1.54	2.54	1.24	
3400		3.69	1.66	2.66	1.30	
3500		3.72	1.68	2.68	1.31	
3600		3.47	1.56	2.56	1.25	
3700		2.91	1.31	2.31	1.13	
3800		1.43	0.64	1.64	0.80	
3900		0.32	0.14	1.14	0.56	
4000		-0.87	-0.39	0.61	0.30	
4100		-1.42	-0.64	0.36	0.18	
4200		-2.05	-0.92	0.08	0.04	
4300	1.00	-2.71	-1.22			
4400						
4500						
4600						
4700						$\Sigma P = 9.48\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.



Channel 4
Stations 6 - 10
Date: 7-28-76
Lag Time: 2.16 Hr.
Daylight
Daylight
No Data
10
6
6
10
D.O. mg/ℓ
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
TIME IN HOURS

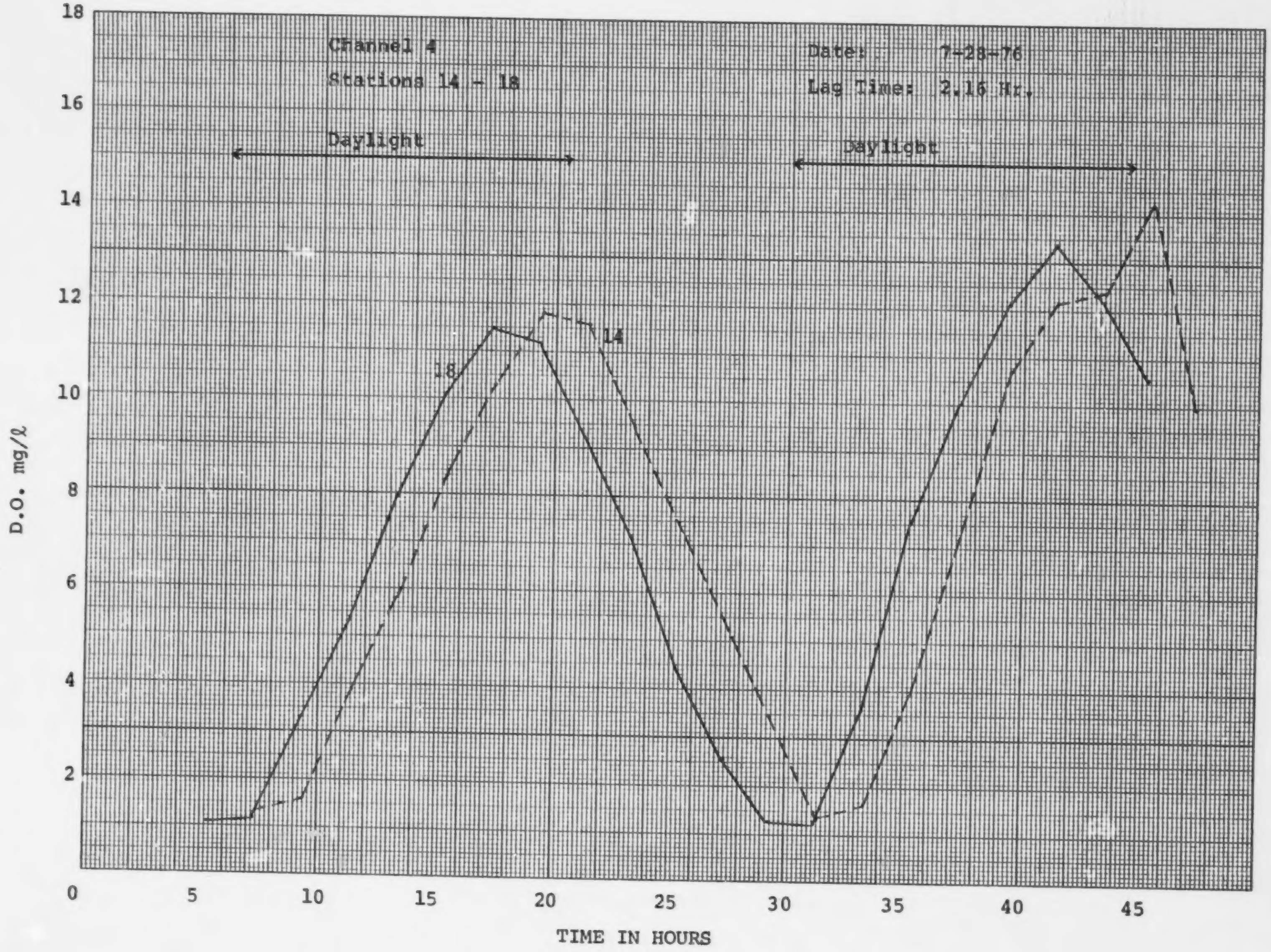
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 6 to 10 in Channel 4

Date: 7-28-76 Travel Time: 2.16

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						1. Error in Station 10
0100						27.33 hr D.O. measure-
0200						ment.
0300						2. Residence time is not
0400						correct so R-value is
0500						difficult to determine.
0600						3. Will use R-value computed
0700						between stations 14 to 18
0800	1.23	0.09	0.04	1.27	0.33	in channel 4.
0900		1.19	0.55	1.78	0.47	
1000		1.91	0.88	2.11	0.55	
1100		2.35	1.09	2.32	0.60	
1200		2.32	1.07	2.30	0.60	
1300		2.10	0.97	2.20	0.58	
1400		2.13	0.99	2.22	0.58	
1500		2.34	1.08	2.31	0.60	
1600		2.29	1.06	2.29	0.60	
1700		2.10	0.97	2.20	0.58	
1800		1.56	0.72	1.95	0.51	
1900		0.83	0.38	1.61	0.42	
2000	1.23	-0.23	-0.11	1.12	0.29	
2100		-1.36	-0.63	0.60	0.16	
2200						
2300						
2400						$\Sigma P = 16.38\ g\ m^{-2}\ day^{-1}$
2500						
2600						$\bar{R} = 1.23\ g\ m^{-3}\ hr^{-1}$
2700						
2800						
2900						
3000	1.23	-1.51	-0.70	0.53	0.28	
3100		-1.11	-0.51	0.72	0.38	
3200		-0.10	-0.05	1.18	0.63	
3300		1.05	0.49	1.72	0.91	
3400		1.88	0.87	2.10	1.11	
3500		2.41	1.12	2.35	1.25	
3600		2.68	1.24	2.47	1.31	
3700		2.97	1.38	2.60	1.38	
3800		2.86	1.32	2.55	1.35	
3900		2.47	1.14	2.37	1.26	
4000		2.22	1.03	2.26	1.20	
4100		2.12	0.98	2.21	1.17	
4200		1.42	0.66	1.89	1.00	
4300		0.44	0.20	1.43	0.76	
4400	1.23	-0.35	0.16	1.07	0.57	
4500		-1.01	0.47	0.76	0.40	
4600						
4700						$\Sigma P = 14.96\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 4
Stations 14 - 18
Date: 7-28-76
Lag Time: 2.16 Hr.
Daylight
Daylight
18
14
D.O. mg/ℓ
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45
TIME IN HOURS

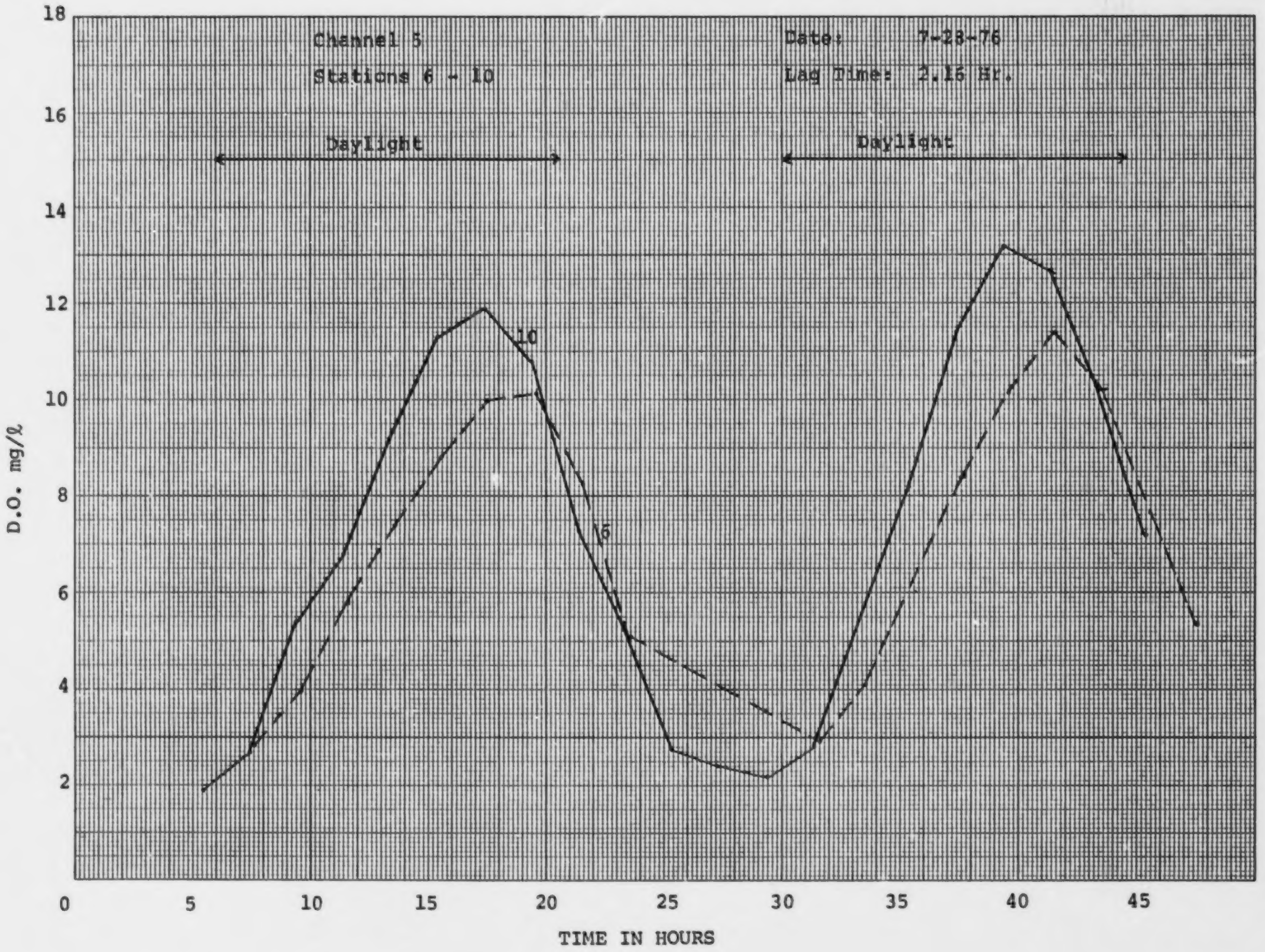
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 14 to 18 in Channel 4

Date: 7-28-76 Travel Time: 2.16 Hrs.

Time at Downstream Station (hrs)	R $g\,m^{-3}\,hr^{-1}$	ΔD.O. $g\,m^{-3}$	ΔD.O. $g\,m^{-3}\,hr^{-1}$	P $g\,m^{-3}\,hr^{-1}$	P $g\,m^{-2}\,hr^{-1}$	Comments
0000 **						
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800	1.23	0.53	0.24	1.48	0.73	
0900		1.42	0.66	1.89	0.93	
1000		1.77	0.82	2.05	1.00	
1100		1.63	0.76	1.98	0.97	
1200		1.80	0.83	2.06	1.01	
1300		2.09	0.97	2.20	1.08	
1400		2.09	0.97	2.20	1.08	
1500		1.88	0.87	2.10	1.03	
1600		1.68	0.78	2.01	0.98	
1700		1.39	0.64	1.87	0.92	
1800		0.72	0.33	1.56	0.76	
1900		-0.24	-0.11	1.12	0.55	
2000		-1.23	-0.57	0.66	0.32	
2100	1.23	-2.11	-0.98	0.25	0.12	
2200						
2300	1.10					
2400	1.19					$\Sigma P = 11.48\ g\ m^{-2}\ day^{-1}$
2500	1.35					
2600	1.41					$\bar{R} = 1.23\ g\ m^{-3}\ hr^{-1}$
2700	1.35					
2800	1.25					
2900	1.06					
3000	1.23	-1.55	-0.72	0.51	0.25	
3100		-0.57	-0.26	0.97	0.48	
3200		0.56	0.26	1.49	0.73	
3300		1.52	0.70	1.93	0.95	
3400		2.64	1.22	2.45	1.20	
3500		3.52	1.63	2.86	1.40	
3600		3.49	1.62	2.85	1.40	
3700		3.10	1.44	2.66	1.30	
3800		2.47	1.14	2.37	1.16	
3900		1.94	0.90	2.13	1.04	
4000		1.45	0.67	1.90	0.93	
4100		1.31	0.61	1.84	0.90	
4200		0.79	0.37	1.59	0.78	
4300		0.08	0.04	1.27	0.62	
4400		-1.18	-0.55	0.68	0.33	
4500	1.23			-0.14		
4600						
4700						$\Sigma P = 13.47\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.



Channel 5
Stations 6 - 10
Date: 7-28-76
Lag Time: 2.16 Hr.
Daylight
Daylight
10
D.O. mg/ℓ
TIME IN HOURS
0
2
4
6
8
10
12
14
16
18
5
15
20
25
30
35
40
45

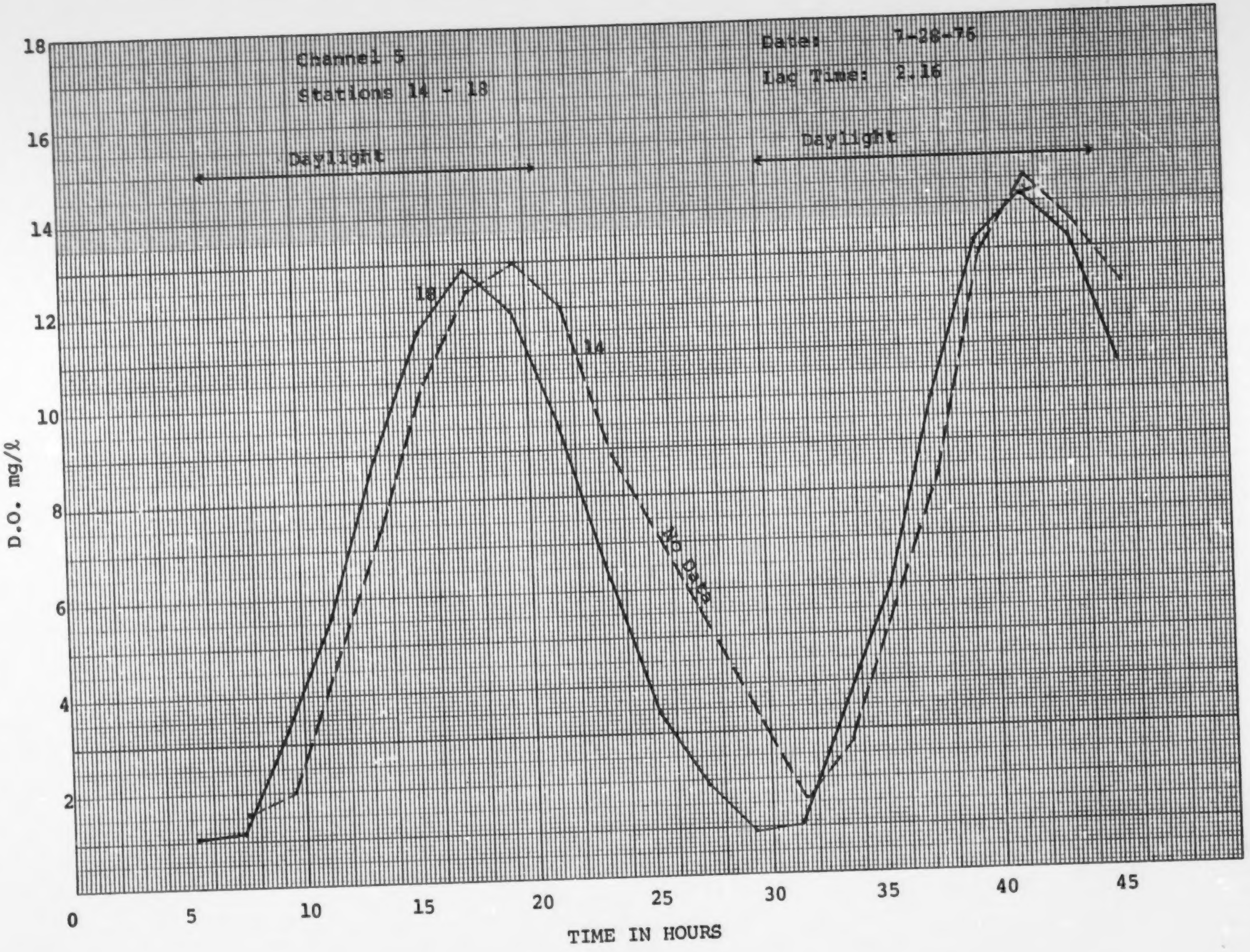
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 6 to 10 in Channel 5

Date: 7-28-76 | Travel Time: 2.16 Hrs

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						1. Residence time is not
0100						correct so R-value is
0200						difficult to determine.
0300						2. Will use R-value
0400						computed between
0500						stations 14 to 18 in
0600	↑					channel 5.
0700						
0800	1.33	0.42	0.19	1.52	0.81	
0900		1.18	0.55	1.88	1.00	
1000		1.47	0.68	2.01	1.07	
1100		1.26	0.58	1.91	1.01	
1200		1.37	0.63	1.96	1.04	
1300		1.79	0.83	2.16	1.14	
1400		2.16	1.00	2.33	1.23	
1500		2.46	1.14	2.47	1.30	
1600		2.45	1.13	2.46	1.30	
1700		2.16	1.00	2.33	1.23	
1800		1.61	0.74	2.08	1.10	
1900	↓	0.95	0.44	1.77	0.90	
2000	1.33	0	0.00	1.33	0.70	
2100		-0.82	-0.38	0.95	0.50	
2200						
2300						
2400					$\Sigma P = 14.33\ g\ m^{-2}\ day^{-1}$	
2500						
2600					$\bar{R} = 1.33\ g\ m^{-3}\ hr^{-1}$	
2700						
2800						
2900						
3000	1.33	-1.03	-0.48	0.85	0.45	
3100		-0.41	-0.19	1.14	0.60	
3200		0.45	0.21	1.54	0.82	
3300		1.19	0.55	1.88	1.00	
3400		1.75	0.81	2.14	1.13	
3500		2.02	0.94	2.26	1.20	
3600		2.48	1.15	2.48	1.31	
3700		3.00	1.39	2.72	1.44	
3800		3.21	1.49	2.82	1.49	
3900		3.20	1.48	2.81	1.49	
4000		2.65	1.23	2.56	1.36	
4100		1.74	0.81	2.14	1.13	
4200		0.74	0.34	1.67	0.89	
4300	↓	0.14	0.06	1.40	0.74	
4400	1.33	-0.35	-0.16	1.17	0.62	
4500		-0.66	-0.31	1.02	0.54	
4600						
4700					$\Sigma P = 16.21\ g\ m^{-2}\ day^{-1}$	

**Daylight savings time.


Channel 5
Stations 14 - 18
Date: 7-28-75
Lag Time: 2.16
Daylight
Daylight
18
14
No Data
D.O. mg/ℓ
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
TIME IN HOURS

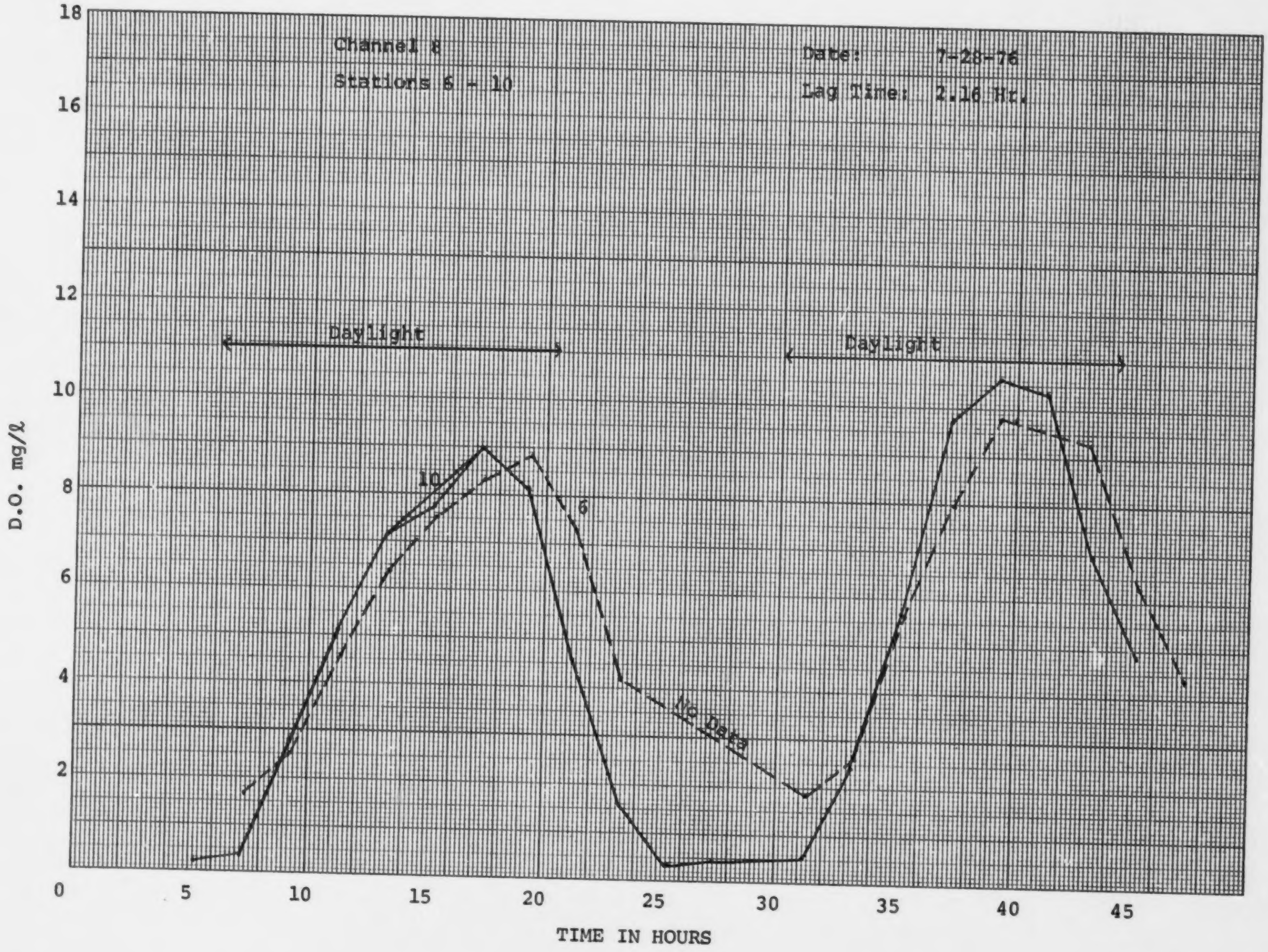
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 14 to 18 in Channel 5

Date: 7-28-76 Travel Time: 2.16 Hrs

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						Only one hour was used to complete respiration rate, due to lack of D.O. data
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800	1.33	0.18	0.08	1.41	0.69	
0900		1.04	0.48	1.81	0.89	
1000		1.47	0.68	2.01	0.98	
1100		1.25	0.60	1.91	0.94	
1200		1.45	0.67	2.00	0.98	
1300		1.75	0.81	2.14	1.05	
1400		1.74	0.81	2.14	1.05	
1500		1.49	0.69	2.02	0.99	
1600		1.09	0.50	1.83	0.90	
1700		0.78	0.36	1.69	0.83	
1800		0.05	0.02	1.35	0.66	
1900		-0.62	-0.29	1.04	0.51	
2000		-1.59	-0.74	0.59	0.29	
2100	1.33	-2.34	-1.08	0.25	0.12	
2200						
2300	1.33					
2400					ΣP = 10.88 $g\ m^{-2}\ day^{-1}$	
2500						
2600					$\bar{R}$ = 1.33 $g\ m^{-3}\ hr^{-1}$	
2700						
2800						
2900						
3000	1.33					
3100						
3200		0	0.00	1.33	0.65	
3300		0.63	0.29	1.62	0.79	
3400		0.96	0.44	1.77	0.87	
3500		1.70	0.79	2.12	1.04	
3600		1.09	0.50	1.83	0.90	
3700		1.70	0.79	2.12	1.04	
3800		1.72	0.80	2.13	1.04	
3900		1.53	0.71	2.04	1.00	
4000		0.23	0.11	1.44	0.71	
4100		-0.05	-0.02	1.31	0.64	
4200		-0.50	-0.23	1.10	0.54	
4300		-0.42	-0.19	1.14	0.56	
4400	1.33	-0.82	-0.38	0.95	0.47	
4500		-2.54	-1.18	0.15	0.07	
4600						
4700					ΣP = 10.32 $g\ m^{-2}\ day^{-1}$	

**Daylight savings time.


Channel 8
Stations 6 - 10
Date: 7-28-76
Lag Time: 2.16 Hr.
Daylight
Daylight
10
6
No Data
D.O. mg/ℓ
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
TIME IN HOURS

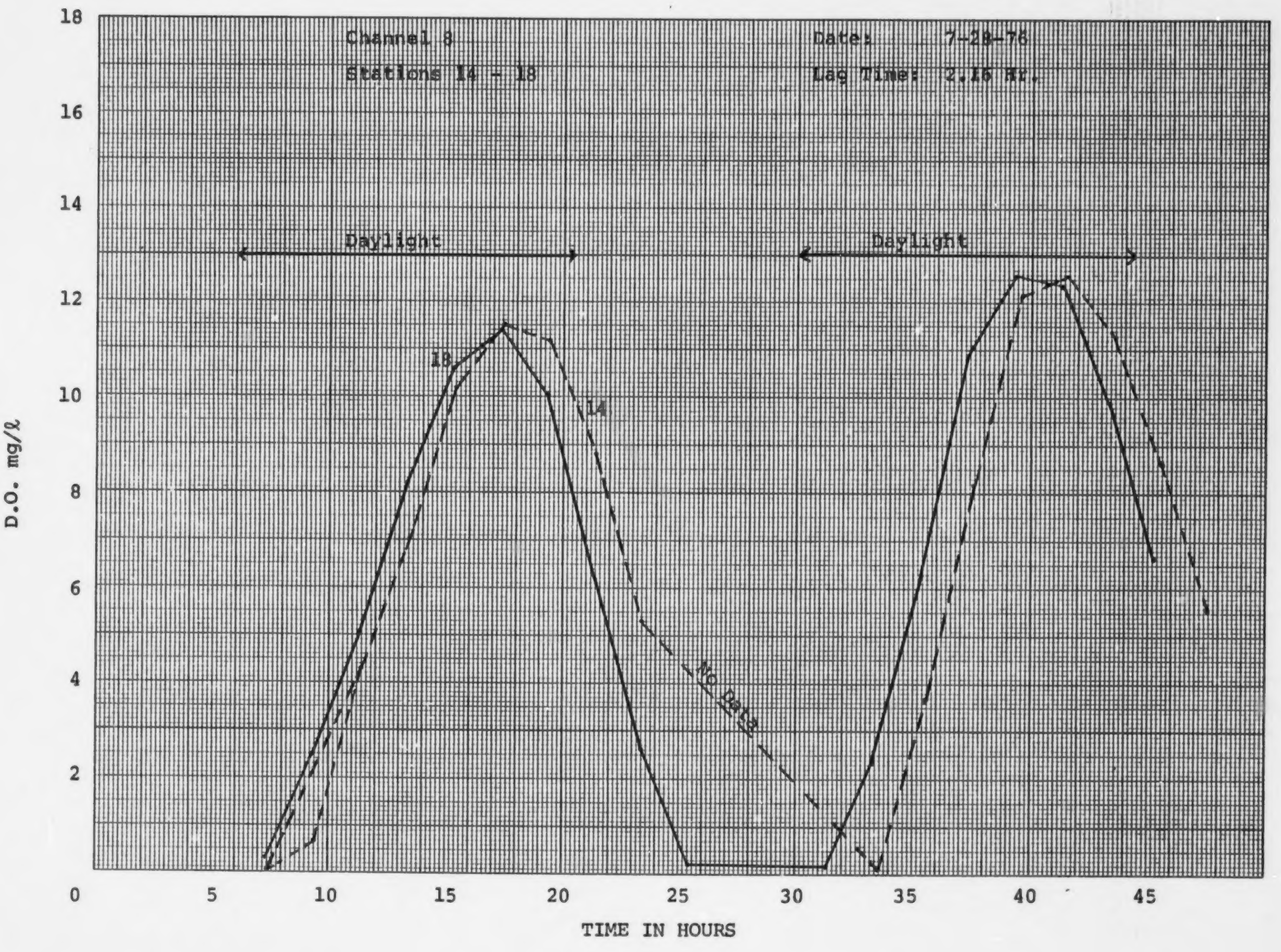
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 6 to 10 in Channel 8

Date: 7-28-76 Travel Time: 2.16 Hrs

Time at Downstream Station (hrs)	R $g\,m^{-3}\,hr^{-1}$	ΔD.O. $g\,m^{-3}$	ΔD.O. $g\,m^{-3}\,hr^{-1}$	P $g\,m^{-3}\,hr^{-1}$	P $g\,m^{-2}\,hr^{-1}$	Comments
0000 **						1. D.O. measurement error seems to exist at Station 10 for 15.30 Hrs.
0100						
0200						
0300						2. Only one hour was used to compute respiration rate, due to lack of D.O. data.
0400						
0500						
0600						
0700						
0800						
0900	1.20	0	0.00	1.20	0.64	
1000		0.40	0.18	1.39	0.74	
1100		0.55	0.26	1.45	0.77	
1200		0.67	0.31	1.51	0.80	
1300		0.77	0.36	1.56	0.83	
1400		0.76	0.35	1.55	0.82	
1500		0.61	0.28	1.48	0.78	
1600		0.61	0.28	1.48	0.78	
1700		0.68	0.32	1.51	0.80	
1800		0.23	0.11	1.31	0.69	
1900		-0.47	-0.22	0.98	0.52	
2000		-1.44	-0.67	0.53	0.28	
2100	1.20	-2.42	-1.12	0.08	0.04	
2200						
2300	1.20					
2400					$\Sigma P = 8.49\ g\ m^{-2}\ day^{-1}$	
2500						
2600					$\bar{R} = 1.20\ g\ m^{-3}\ hr^{-1}$	
2700						
2800						
2900						
3000						
3100						
3200	1.20	-0.89	-0.41	0.79	0.42	
3300		-0.31	-0.14	1.06	0.56	
3400		0.10	0.05	1.25	0.66	
3500		0.20	0.09	1.29	0.68	
3600		0.75	0.35	1.55	0.82	
3700		1.56	0.72	1.92	1.02	
3800		1.54	0.71	1.91	1.01	
3900		1.06	0.49	1.69	0.90	
4000		0.81	0.38	1.58	0.84	
4100		0.77	0.36	1.56	0.83	
4200		-0.20	-0.09	1.11	0.59	
4300		-1.78	-0.82	0.38	0.20	
4400		-1.86	-0.86	0.34	0.18	
4500	1.20	-2.43	-1.12	0.08	0.04	
4600						
4700					$\Sigma P = 8.75\ g\ m^{-2}\ day^{-1}$	

**Daylight savings time.


Channel 8
Stations 14 - 18
Date: 7-28-76
Lag Time: 2.16 Hr.
Daylight
Daylight
18
14
No Data
D.O. mg/ℓ
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45
TIME IN HOURS

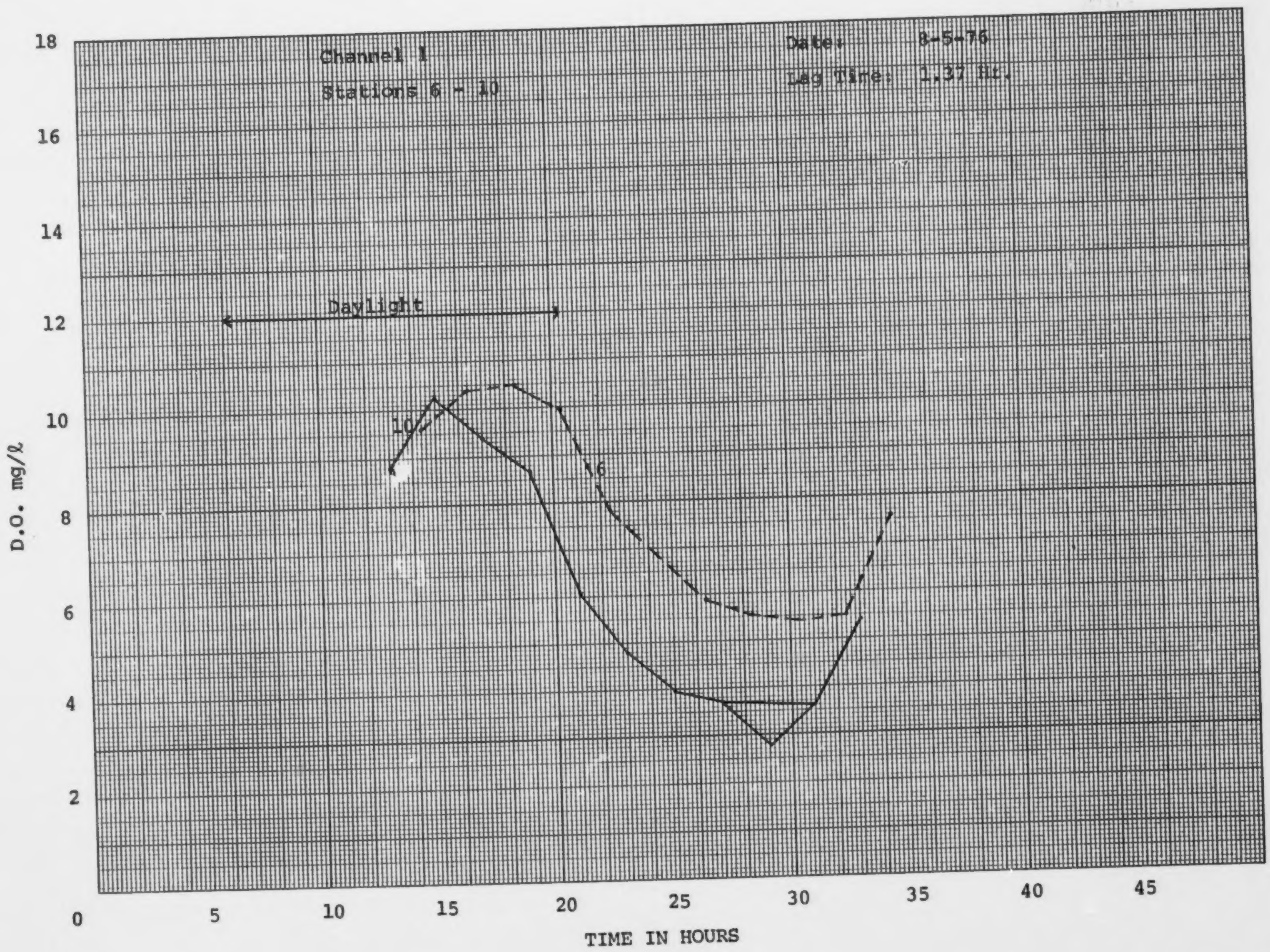
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 14 to 18 in Channel 8

Date: 7-28-76 Travel Time: 2.16 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						
0100						Only one hour used to compute the respiration rate due to lack of D.O. data.
0200						
0300						
0400						
0500						
0600 ↑						
0700						
0800	1.22	0.32	0.15	1.37	0.67	
0900	↓	0.34	0.16	1.38	0.68	
1000		0.45	0.21	1.43	0.70	
1100		0.69	0.32	1.54	0.75	
1200		1.00	0.46	1.68	0.82	
1300		1.25	0.58	1.80	0.88	
1400		1.08	0.50	1.72	0.84	
1500		0.68	0.32	1.53	0.75	
1600		0.30	0.14	1.36	0.67	
1700		0.05	0.02	1.24	0.61	
1800		-0.42	-0.19	1.03	0.50	
1900		-0.95	-0.44	0.78	0.38	
2000 ↓		-1.65	-0.76	0.46	0.23	
2100	1.22	-2.35	-1.09	0.13	0.06	
2200						
2300	1.22					
2400					$\Sigma P = 8.54\ g\ m^{-2}\ day^{-1}$	
2500						
2600					$\bar{R} = 1.22\ g\ m^{-3}\ hr^{-1}$	
2700						
2800						
2900						
3000 ↑						
3100						
3200						
3300						
3400	1.22	2.83	1.31	2.53	1.24	
3500	↓	2.96	1.37	2.59	1.27	
3600		3.17	1.47	2.69	1.32	
3700		3.32	1.54	2.76	1.35	
3800		2.54	1.18	2.40	1.18	
3900		1.33	0.62	1.84	0.90	
4000		0.26	0.12	1.34	0.66	
4100		-0.08	-0.04	1.18	0.58	
4200		-0.71	-0.33	0.89	0.44	
4300 ↓		-1.29	-0.60	0.62	0.30	
4400		-1.81	-0.84	0.38	0.19	
4500	1.22	-2.24	-1.04	0.16	0.08	
4600						
4700					$\Sigma P = 9.51\ g\ m^{-2}\ day^{-1}$	

**Daylight savings time.


Channel I
Stations 6 - 10
Date: 8-5-76
Lag Time: 1.37 Hr.
Daylight
10
6
D.O. mg/ℓ
TIME IN HOURS
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45

HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 6 to 10 in Channel 1

Date: 8-5-76 Travel Time: 1.37 Hr.

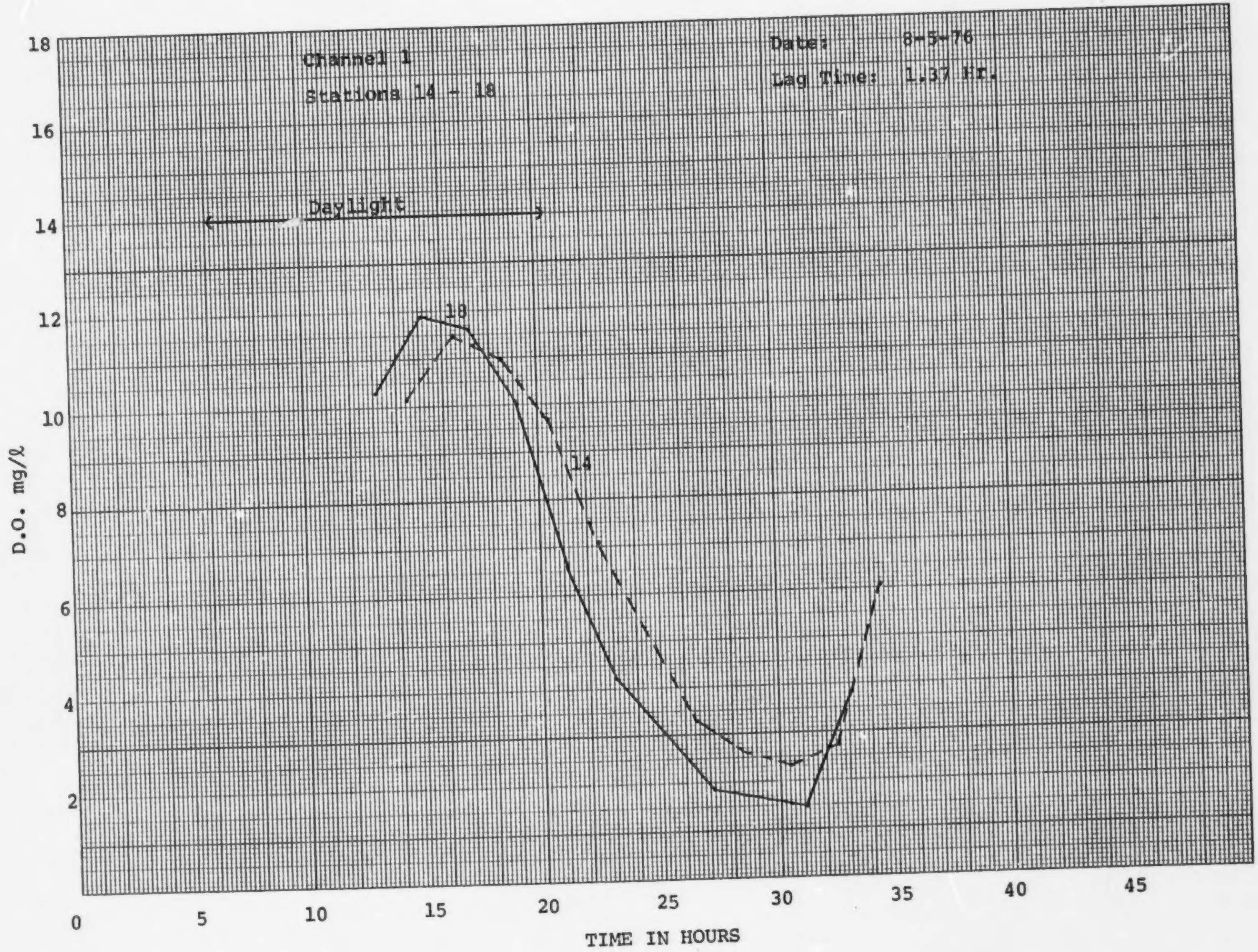
Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						Possible error in D.O.
0100						reading Station 10 -
0200						2900 Hr.
0300						
0400						
0500						
0600						
0700						
0800						
0900						
1000						
1100						
1200						
1300						
1400						
1500	1.68	0.44	0.32	2.00	1.06	
1600		-0.39	-0.28	1.40	0.74	
1700		-0.99	-0.72	0.96	0.51	
1800		-1.43	-1.04	0.64	0.34	
1900		-1.64	-1.20	0.48	0.25	
2000	1.68	-2.60	-1.90			
2100						
2200	2.04					
2300	1.27					
2400	2.13					
2500	1.90					
2600	1.65					
2700	1.53					
2800	1.48					
2900	1.42					
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						

$\Sigma P = 2.90\ g\ m^{-2}(5\ Hrs)^{-1}$

$\bar{R} = 1.68\ g\ m^{-3}\ hr^{-1}$

$\Sigma P = \quad g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 1
Stations 14 - 18
Date: 8-5-76
Lag Time: 1.37 Hr.
Daylight
18
14
D.O. mg/ℓ
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
TIME IN HOURS

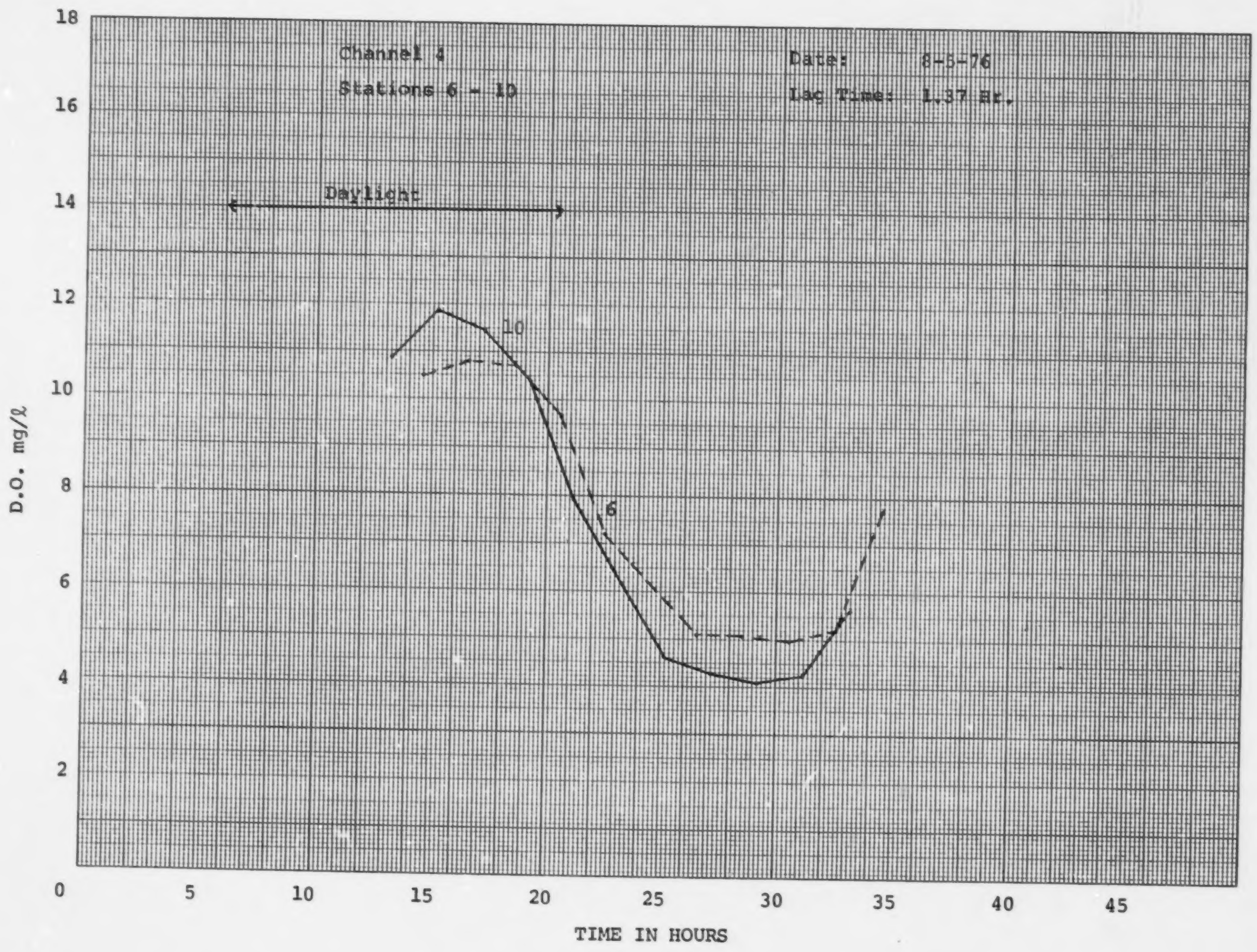
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 14 to 18 in Channel 1

Date: 8-5-76 | Travel Time: 1.37 Hr.

Time at Downstream Station (hrs)	R $g\,m^{-3}\,hr^{-1}$	ΔD.O. $g\,m^{-3}$	ΔD.O. $g\,m^{-3}\,hr^{-1}$	P $g\,m^{-3}\,hr^{-1}$	P $g\,m^{-2}\,hr^{-1}$	Comments
0000 **						D.O. values below 3 mg/ℓ
0100						not used in calculation
0200						of respiration
0300						
0400						
0500						
0600						
0700						
0800						
0900						
1000						
1100						
1200						
1300						
1400						
1500	1.43	1.20	0.88	2.31	1.13	
1600		0.62	0.45	1.88	0.92	
1700		0.18	0.13	1.56	0.76	
1800		-0.26	-0.19	1.24	0.61	
1900		-0.49	-0.36	1.07	0.52	
2000		-1.48	-1.08	0.35	0.17	
2100	1.43	-2.18	-1.59	-0.16		
2200	1.58					
2300	1.64					
2400	1.38					$\Sigma P = 4.11\ g\ m^{-2}(6\ Hrs)^{-1}$
2500	1.12					
2600						$R = 1.43\ g\ m^{-3}\ hr^{-1}$
2700						
2800						
2900						
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = \quad g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 4
Stations 6 - 10
Date: 8-5-76
Lag Time: 1.37 Hr.
Daylight
10
6
D.O. mg/ℓ
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45
TIME IN HOURS

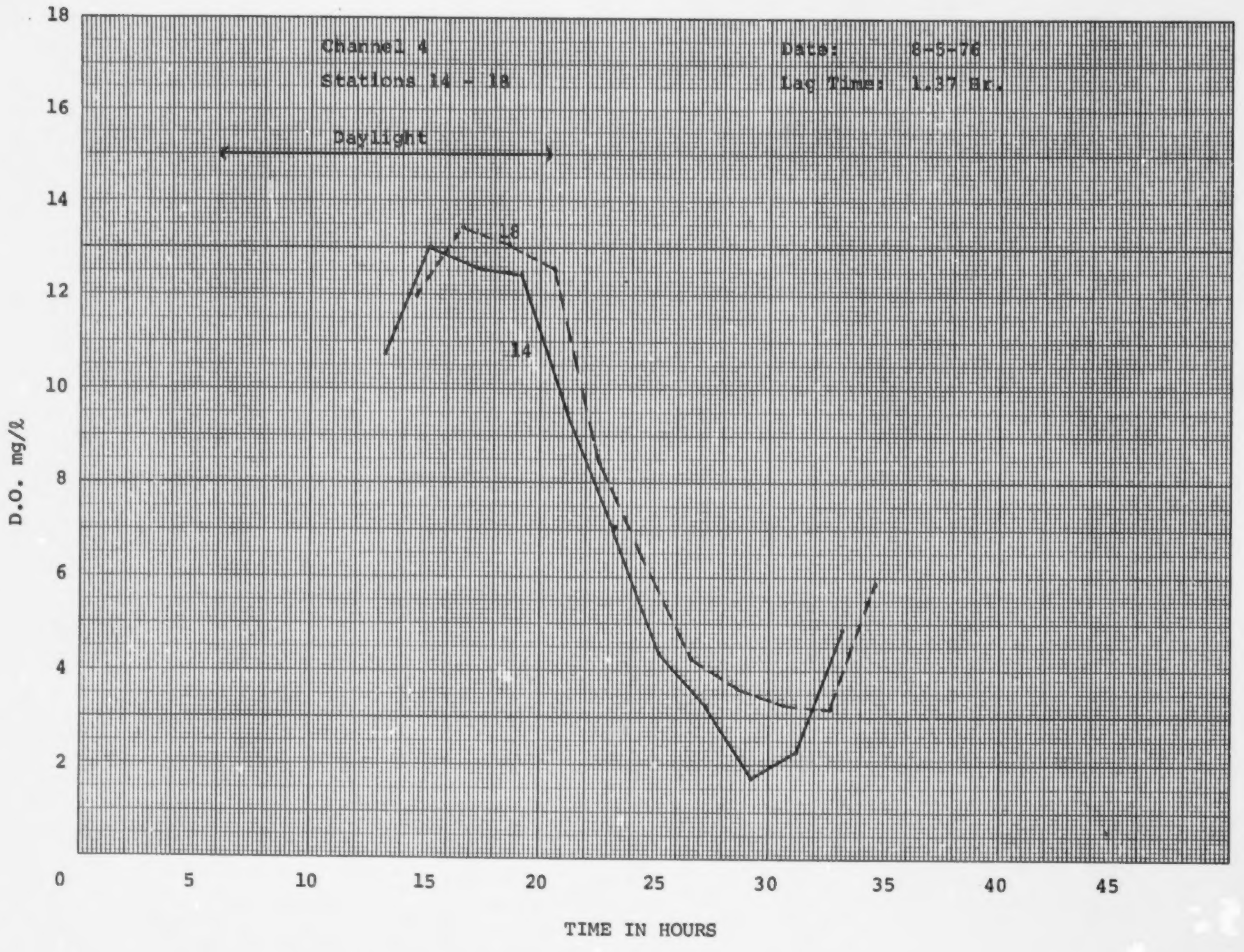
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 6 to 10 in Channel 4

Date: 8-5-76 Travel Time: 1.37 Hr.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000	**					
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800						
0900						
1000						
1100						
1200						
1300						
1400						
1500	0.63	1.20	0.88	1.51	0.80	
1600		1.01	0.74	1.37	0.73	
1700		0.72	0.53	1.16	0.61	
1800		0.33	0.24	0.87	0.46	
1900		0.00	0.00	0.63	0.33	
2000		-0.55	-0.40	0.23	0.12	
2100	0.63	-0.99	-0.72	-0.09		
2200						
2300	0.39					
2400	0.61					$\Sigma P = 3.05\ g\ m^{-2}\ (6\ Hrs)^{-1}$
2500	0.84					
2600	0.66					$R = 0.63\ g\ m^{-3}\ hr^{-1}$
2700	0.58					
2800	0.58					
2900	0.68					
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = \quad g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 4
Stations 14 - 18
Date: 8-5-76
Lag Time: 1.37 Hr.
Daylight
18
14
D.O. mg/ℓ
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
TIME IN HOURS

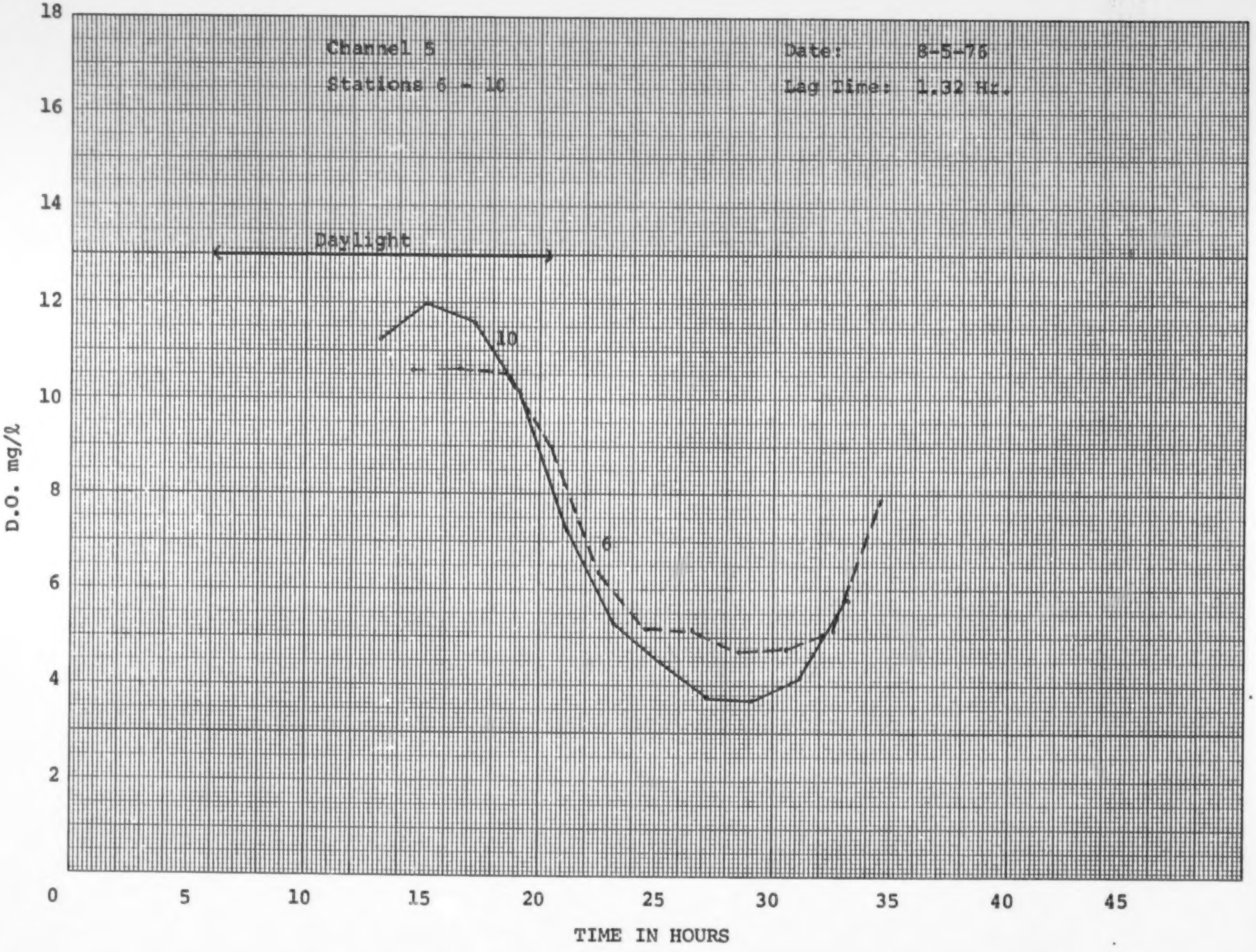
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 14 to 18 in Channel 4

Date: 8-5-76 Travel Time: 1.37 Hr

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						D.O. Values below 3 mg/ℓ were not used in calculating respiration value.
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800						
0900						
1000						
1100						
1200						
1300						
1400						
1500	0.73	0.56	0.41	1.14	0.56	
1600		-0.18	-0.13	0.60	0.29	
1700		-0.74	-0.54	0.19	0.09	
1800		-0.66	-0.48	0.25	0.12	
1900		-0.53	-0.39	0.34	0.17	
2000	0.73	-1.48	-1.08			
2100						
2200						
2300	0.57					
2400	0.85					$\Sigma P = 1.23\ g\ m^{-2} (5\ Hrs)^{-1}$
2500	0.96					
2600	0.69					$R = 0.73\ g\ m^{-3}\ hr^{-1}$
2700	0.55					
2800						
2900						
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P =\ \ \ \ g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 5
Stations 6 - 10
Date: 8-5-76
Lag Time: 1.32 Hr.
Daylight
10
6
D.O. mg/ℓ
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45
TIME IN HOURS

HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 6 to 10 in Channel 5

Date: 8-5-76 Travel Time: 1.32

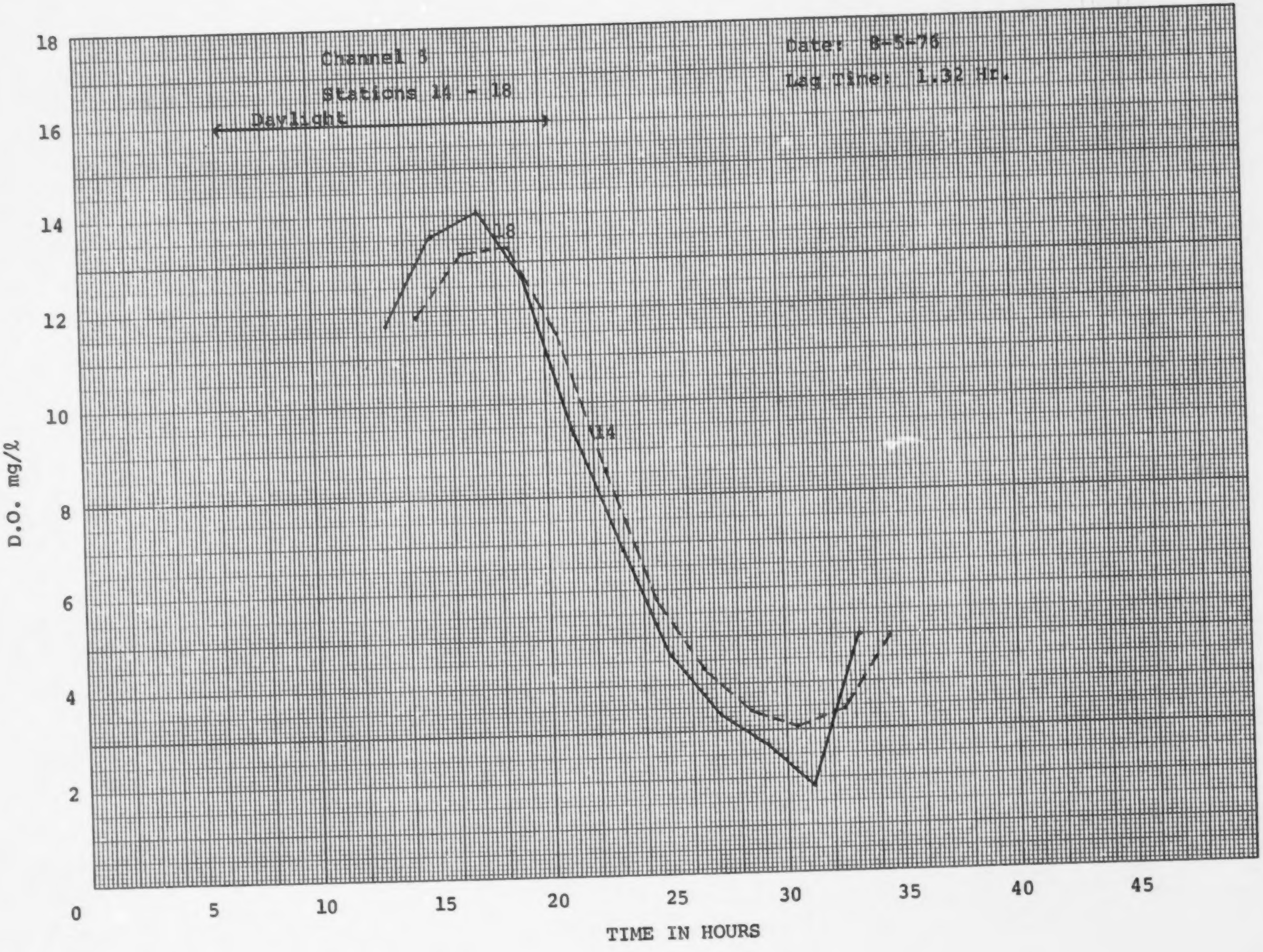
Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800						
0900						
1000						
1100						
1200						
1300						
1400						
1500	0.63	1.32	1.00	1.63	0.86	
1600		1.34	1.02	1.65	0.87	
1700		1.06	0.80	1.43	0.76	
1800		0.47	0.36	0.99	0.52	
1900		0.05	0.04	0.67	0.36	
2000		-0.45	-0.34	0.29	0.15	
2100	0.63	-0.83	-0.63	0.00		
2200	0.45					
2300	0.45					
2400	0.41					
2500	0.46					
2600	0.73					
2700	0.92					
2800	0.83					
2900	0.76					
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						

$\Sigma P = 3.52\ g\ m^{-2}\ (6\ Hrs)^{-1}$

$\bar{R} = 0.63\ g\ m^{-3}\ hr^{-1}$

$\Sigma P = \quad g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel B
Stations 14 - 18
Daylight
Date: 8-5-76
Lag Time: 1.32 Hr.
18
14
D.O. mg/ℓ
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
TIME IN HOURS

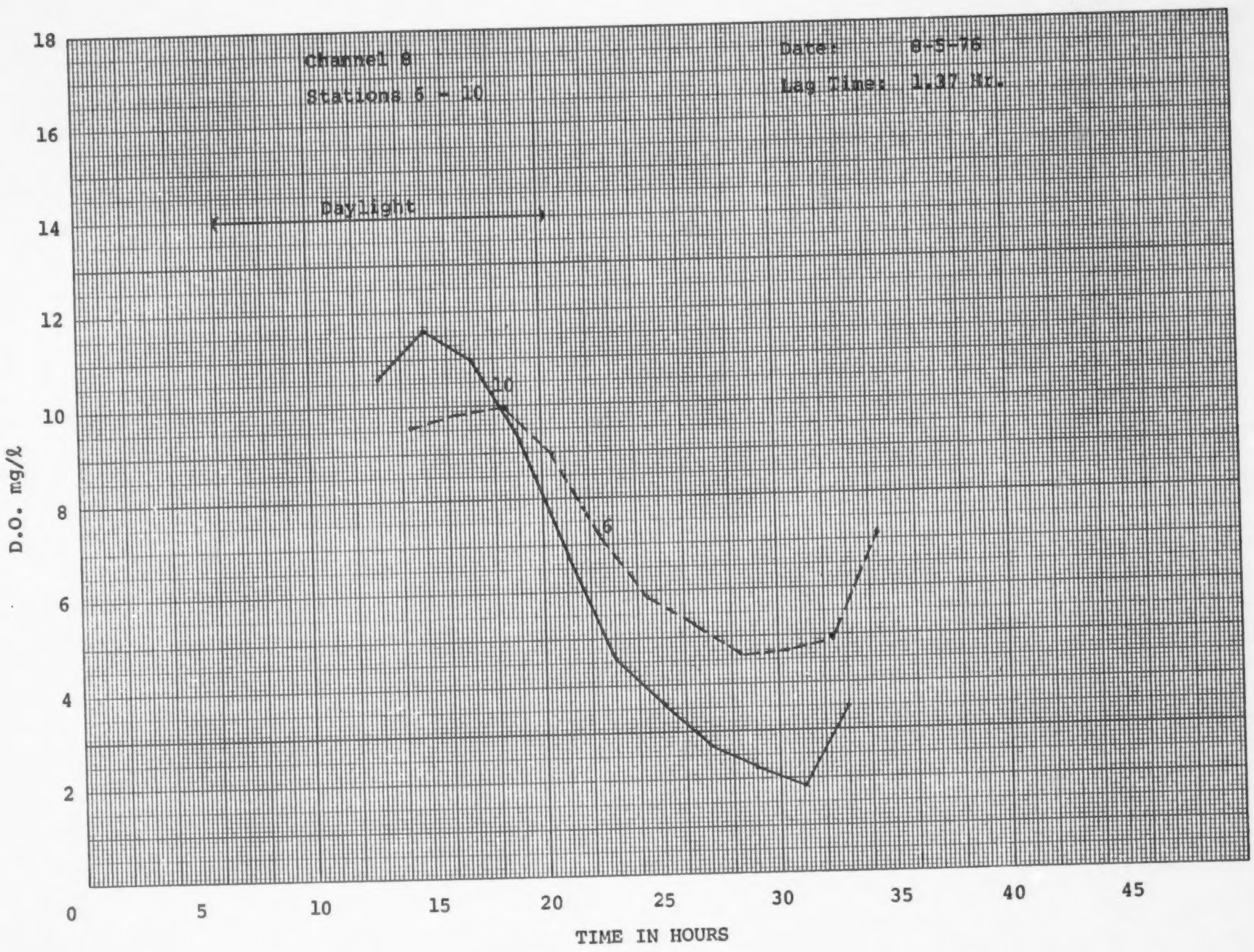
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 14 to 18 in Channel 5

Date: 8-5-76 Travel Time: 1.32

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						D.O. values below 3 mg/ℓ were not used in calculation of respiration value.
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800						
0900						
1000						
1100						
1200						
1300						
1400						
1500	0.54	1.26	0.95	1.49	0.73	
1600		0.90	0.68	1.22	0.60	
1700		0.80	0.61	1.15	0.56	
1800		0.24	0.18	0.72	0.35	
1900		-0.08	-0.06	0.48	0.24	
2000		-0.68	-0.52	0.02	0.01	
2100	0.54	-1.22				
2200	0.80					
2300	0.64					
2400	0.49					$\Sigma P = 2.49\ g\ m^{-2}(6\ Hrs)^{-1}$
2500	0.55					
2600	0.47					$\bar{R} = 0.54\ g\ m^{-3}\ hr^{-1}$
2700	0.42					
2800	0.42					
2900						
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P =\quad g\ m^{-2}\ day^{-1}$

**Daylight savings time.



Channel 8
Stations 6 - 10
Date: 8-5-76
Lag Time: 1.37 Hr.
Daylight
10
6
D.O. mg/ℓ
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
TIME IN HOURS

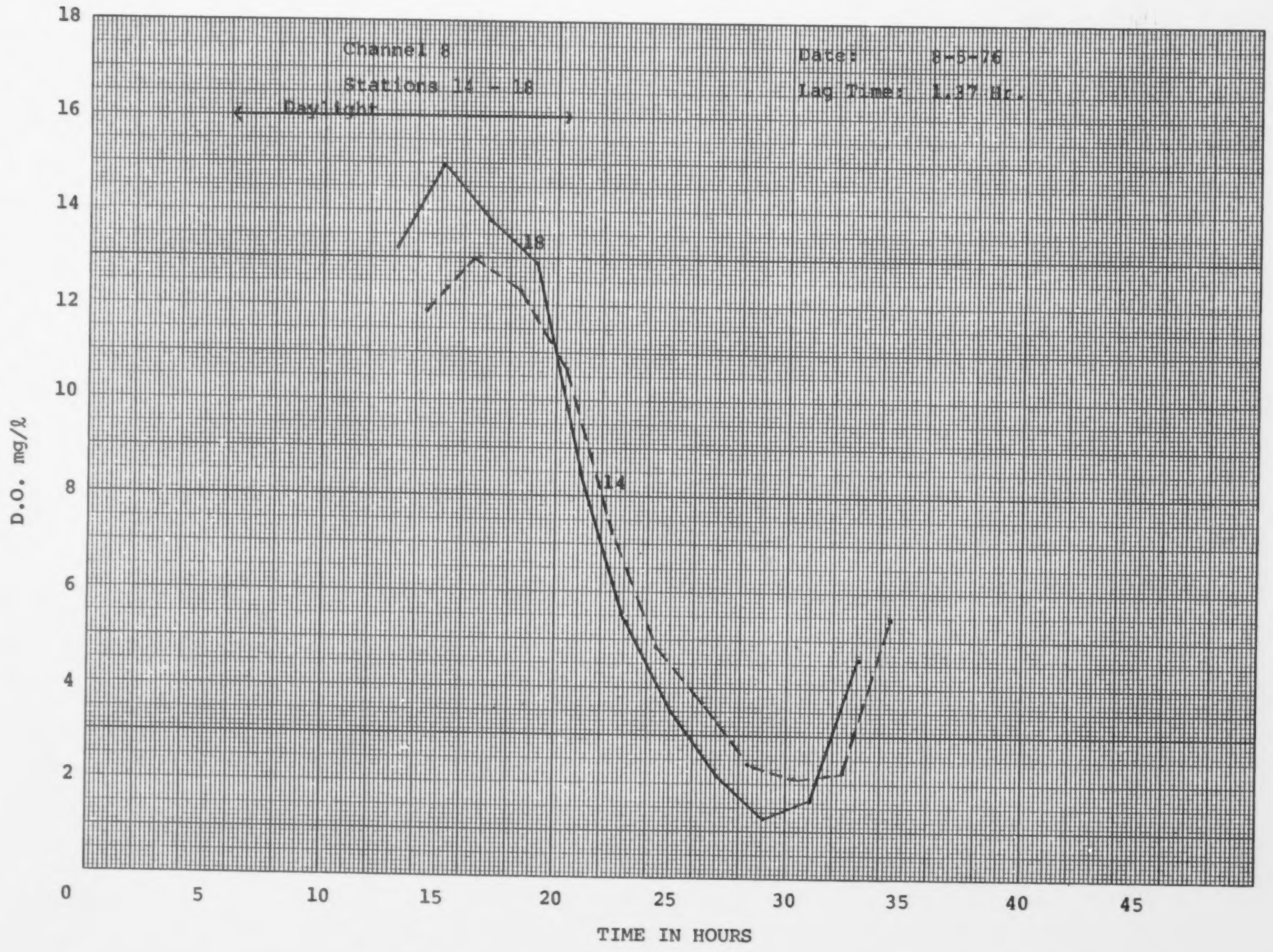
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 6 to 10 in Channel 8

Date: 8-5-76 Travel Time: 1.37 Hrs

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						D.O. values below 3 mg/ℓ were not used in calculation of respiration
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800						
0900						
1000						
1100						
1200						
1300						
1400						
1500	1.52	1.96	1.43	2.95	1.56	
1600		2.04	1.49	3.01	1.60	
1700		1.16	0.85	2.37	1.26	
1800		0.27	0.20	1.72	0.91	
1900		-0.30	-0.22	1.30	0.69	
2000		-1.06	-0.77	0.75	0.40	
2100	1.52	-1.59	-1.16	0.36	0.19	
2200	1.36					
2300	1.64					
2400	1.50					$\Sigma P = 6.61\ g\ m^{-2}\ (7\ Hrs)^{-1}$
2500	1.51					
2600	1.61					$\bar{R} = 1.52\ g\ m^{-3}\ hr^{-1}$
2700						
2800						
2900						
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P =\quad g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 8
Stations 14 - 18
Daylight
Date: 8-5-76
Lag Time: 1.37 Hr.
18
14
D.O. mg/ℓ
TIME IN HOURS
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45

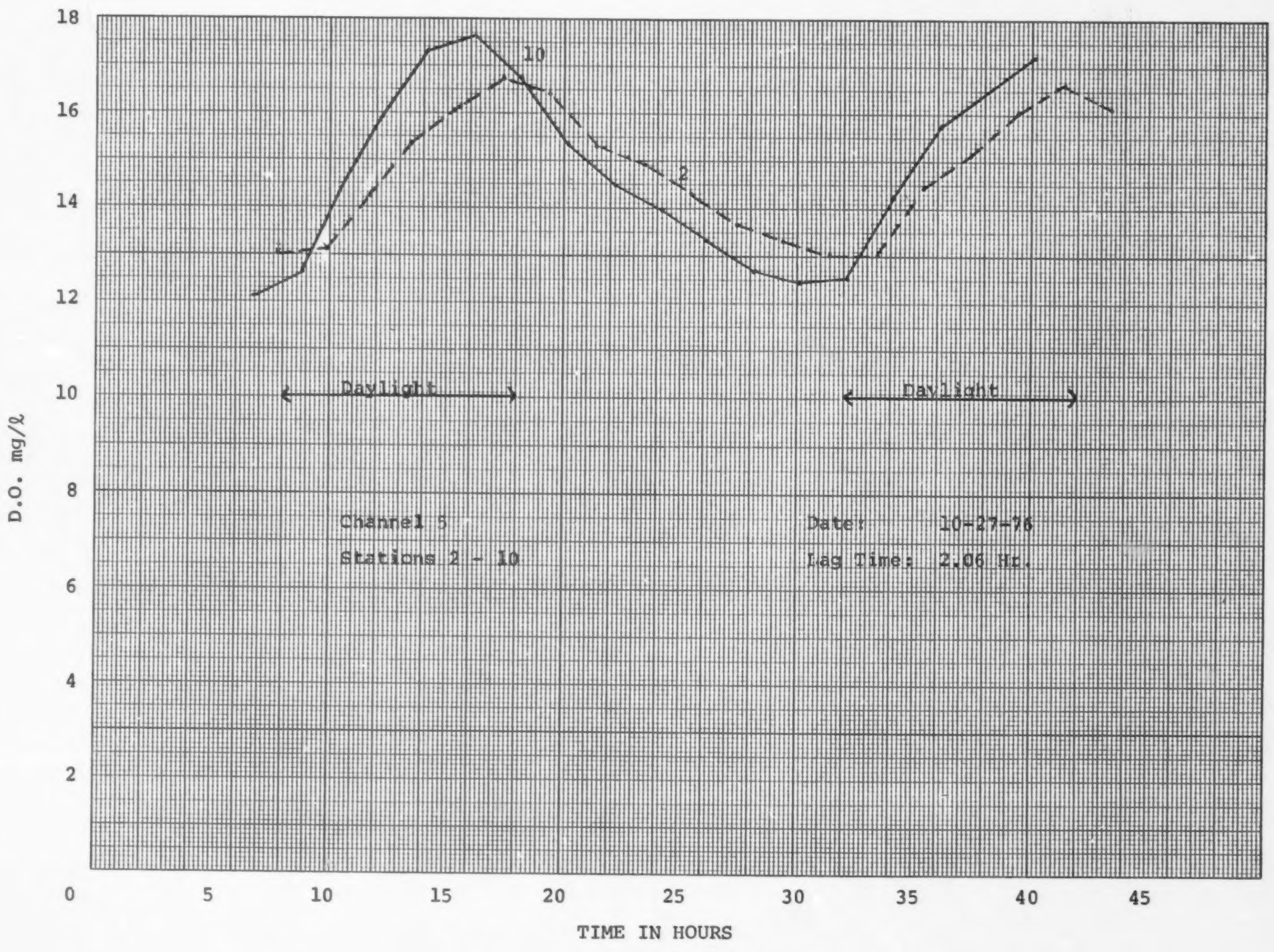
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 14 to 18 in Channel 8

Date: 8-5-76 Travel Time: 1.37 Hrs

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						D.O. values below 3 mg/ℓ
0100						were not used in calculation
0200						of respiration
0300						
0400						
0500						
0600						
0700						
0800						
0900						
1000						
1100						
1200						
1300						
1400						
1500	0.69	2.68	1.96	2.65	1.30	
1600		1.72	1.26	1.95	0.96	
1700		1.08	0.79	1.48	0.73	
1800		0.95	0.69	1.38	0.68	
1900		1.13	0.82	1.51	0.74	
2000		0.00	0.00	0.69	0.34	
2100	0.69	-0.94	0.69	0.00		
2200	0.69					
2300	0.80					
2400	0.60					$\Sigma P = 4.75\ g\ m^{-2}\ (6\ Hrs)^{-1}$
2500	0.67					
2600						$R = 0.69\ g\ m^{-3}\ hr^{-1}$
2700						
2800						
2900						
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = \quad g\ m^{-2}\ day^{-1}$

**Daylight savings time.


18
16
14
12
10
8
6
4
2
0
D.O. mg/ℓ
5
10
15
20
25
30
35
40
45
TIME IN HOURS
10
2
Daylight
Daylight
Channel 5
Stations 2 - 10
Date: 10-27-76
Lag Time: 2.06 Hr.

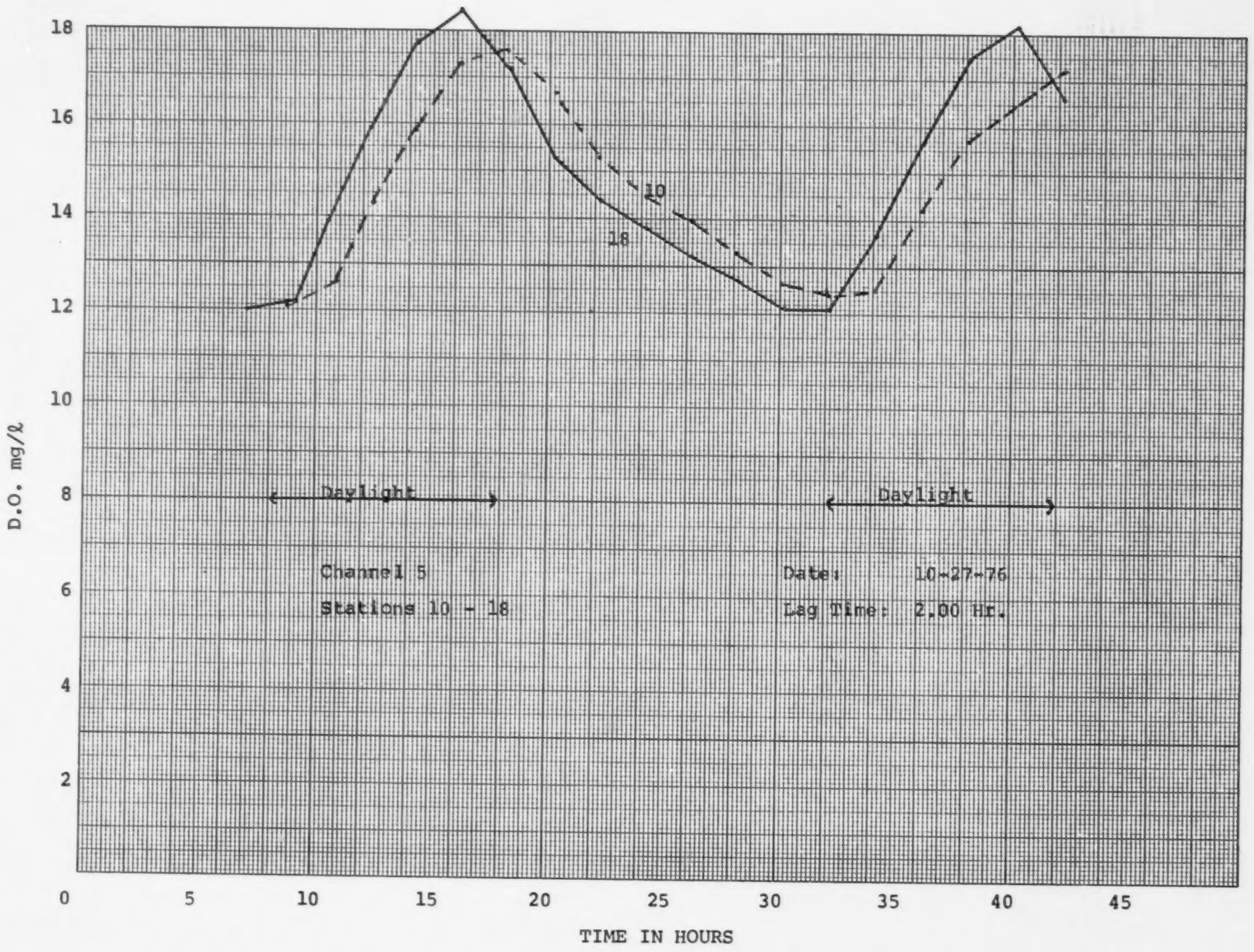
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 2 to 10 in Channel 5

Date: 10-27-76 Travel Time: 2.06 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800	0.37	-0.62	-0.30	0.07	0.02	
0900		-0.25	-0.12	0.25	0.08	
1000		0.71	0.34	0.71	0.24	
1100		1.05	0.51	0.88	0.30	
1200		1.31	0.64	1.01	0.34	
1300		1.46	0.71	1.08	0.37	
1400		1.65	0.80	1.17	0.40	
1500		1.51	0.73	1.10	0.37	
1600		1.32	0.64	1.01	0.34	
1700		0.69	0.33	0.70	0.24	
1800	0.37	0.17	0.08	0.45	0.15	
1900						
2000						
2100	0.27					
2200	0.31					
2300	0.36					
2400	0.36					$\Sigma P = 2.85\ g\ m^{-2}\ day^{-1}$
2500	0.52					
2600	0.38					$\bar{R} = 0.37\ g\ m^{-3}\ hr^{-1}$
2700	0.40					
2800	0.41					
2900	0.41					
3000	0.38					
3100	0.30					
3200	0.37	-0.51	-0.25	0.12	0.04	
3300		0.24	0.12	0.49	0.17	
3400		0.70	0.34	0.71	0.24	
3500		0.74	0.36	0.73	0.34	
3600		1.00	0.49	0.86	0.29	
3700		1.07	0.52	0.89	0.30	
3800		1.07	0.52	0.89	0.30	
3900		0.97	0.47	0.84	0.29	
4000	0.37	0.94	0.46	0.83	0.28	
4100						
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = 2.25\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.


18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
D.O. mg/ℓ
TIME IN HOURS
10
18
Daylight
Daylight
Channel 5
Stations 10 - 18
Date: 10-27-76
Lag Time: 2.00 Hr.

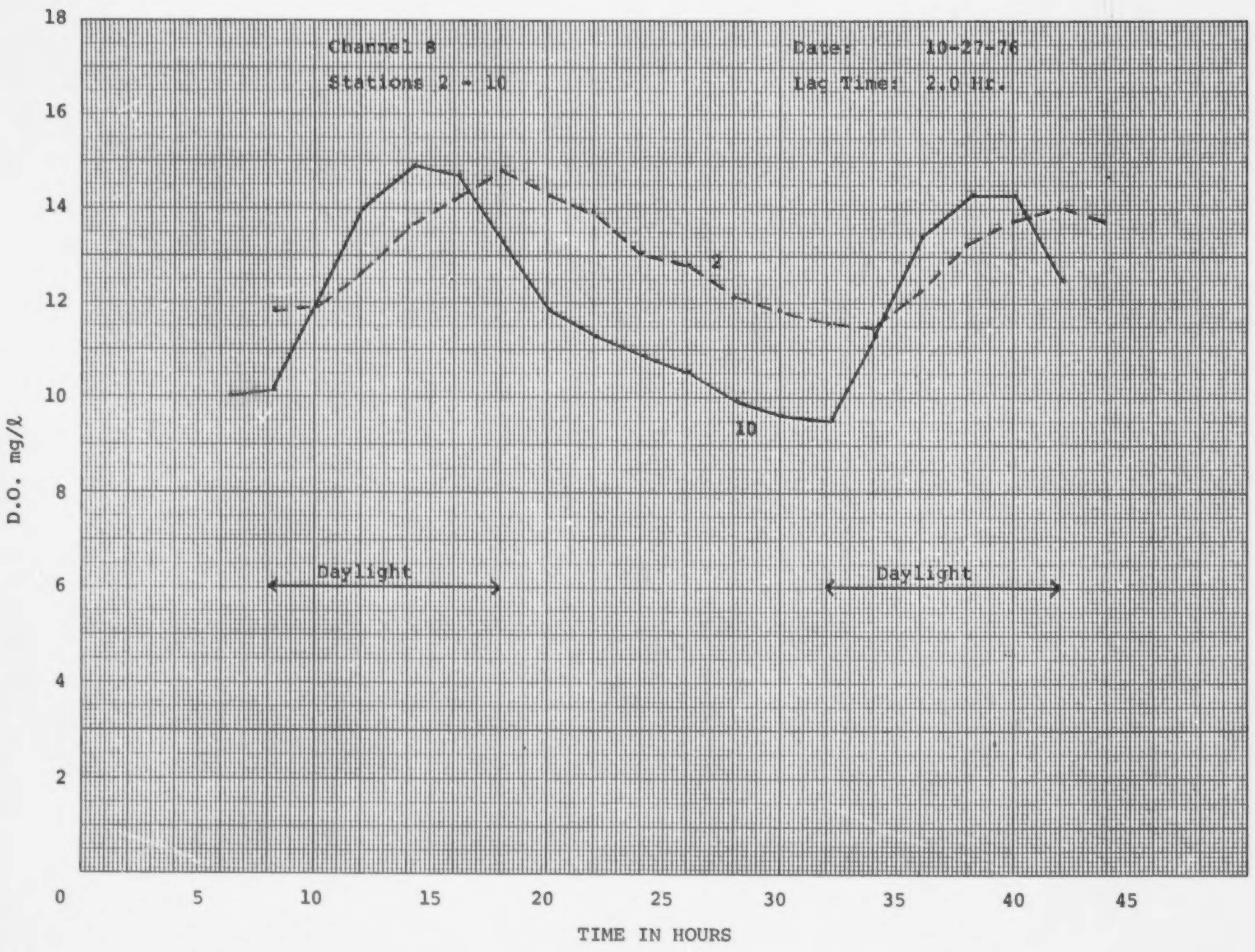
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 10 to 18 in Channel 5

Date: 10-27-76 Travel Time: 2.00 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800						
0900	0.37	0.05	0.03	0.40	0.14	
1000		0.88	0.44	0.81	0.29	
1100		1.64	0.82	1.19	0.43	
1200		1.67	0.84	1.21	0.44	
1300		0.83	0.42	0.79	0.28	
1400		1.79	0.90	1.27	0.46	
1500		1.50	0.75	1.12	0.40	
1600		1.20	0.60	0.97	0.35	
1700	0.37	0.39	0.20	0.57	0.21	
1800		-0.21	-0.11	0.27	0.10	
1900						
2000	0.63					
2100	0.59					
2200	0.47					
2300	0.39					
2400	0.33					$\Sigma P = 3.10\ g\ m^{-2}\ day^{-1}$
2500	0.33					
2600	0.37					$\bar{R} = 0.37\ g\ m^{-3}\ hr^{-1}$
2700	0.33					
2800	0.28					
2900	0.26					
3000	0.25					
3100	0.22					
3200	0.37	-0.31	-0.16	0.22	0.08	
3300		0.29	0.15	0.52	0.19	
3400		1.01	0.51	0.88	0.32	
3500		1.21	0.61	0.98	0.35	
3600		1.35	0.68	1.05	0.38	
3700		1.54	0.77	1.14	0.41	
3800		1.68	0.84	1.21	0.44	
3900		1.72	0.86	1.23	0.44	
4000		1.70	0.85	1.22	0.44	
4100	0.37	0.80	0.40	0.77	0.28	
4200		-0.33	-0.17	0.21	0.08	
4300						
4400						
4500						
4600						
4700						$\Sigma P = 3.41\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.

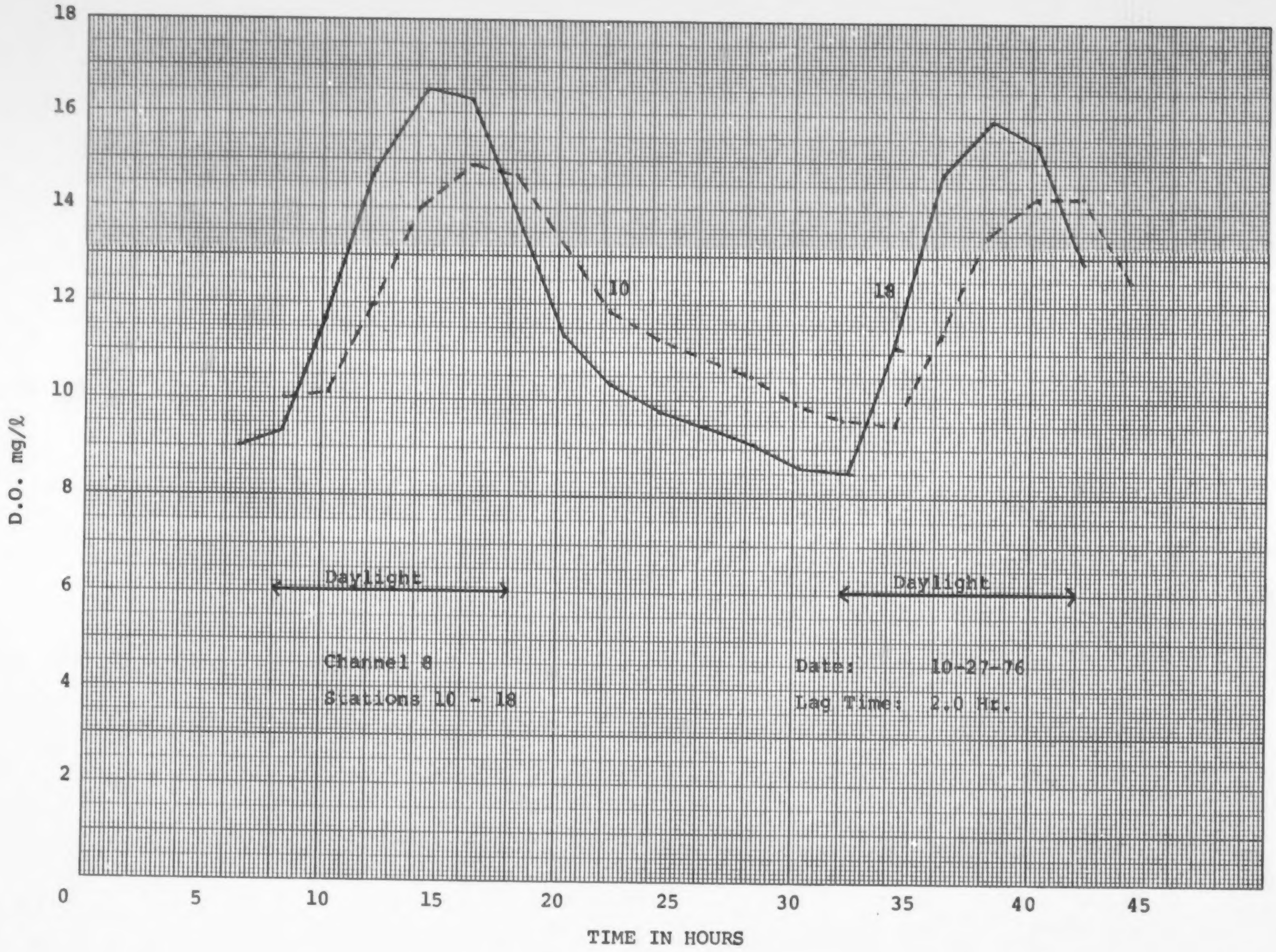

Channel 8
Stations 2 - 10
Date: 10-27-76
Lag Time: 2.0 Hr.
2
10
Daylight
Daylight
D.O. mg/ℓ
TIME IN HOURS
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45

HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL
LOCATION OF REACH: Station 2 to 10 in Channel 8

Date: 10-27-76 Travel Time: 2.00 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800						
0900	1.16	-1.01	-0.50	0.66	0.22	
1000		-0.11	-0.06	1.10	0.37	
1100		0.61	0.31	1.46	0.50	
1200		1.25	0.63	1.79	0.61	
1300		1.30	0.65	1.81	0.62	
1400		1.15	0.58	1.74	0.59	
1500		0.93	0.47	1.63	0.55	
1600		0.55	0.28	1.44	0.49	
1700	1.16	-0.38	-0.19	0.97	0.33	
1800						
1900						
2000	1.20					
2100	1.27					
2200	1.32					
2300	1.20					
2400	1.08					$\Sigma P = 4.28\ g\ m^{-2}\ day^{-1}$
2500	1.12					
2600	1.14					$\bar{R} = 1.16\ g\ m^{-3}\ hr^{-1}$
2700	1.14					
2800	1.12					
2900	1.11					
3000	1.10					
3100	1.16					
3200	1.16	-2.10	-1.05	0.11	0.04	
3300		-1.30	-0.65	0.51	0.17	
3400		-0.35	-0.18	0.99	0.34	
3500		0.35	0.18	1.34	0.46	
3600		1.12	0.56	1.72	0.58	
3700		1.03	0.52	1.68	0.57	
3800		0.92	0.46	1.62	0.55	
3900		0.77	0.39	1.55	0.53	
4000		0.52	0.26	1.42	0.48	
4100	1.16	-0.40	-0.20	0.96	0.33	
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = 4.05\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.

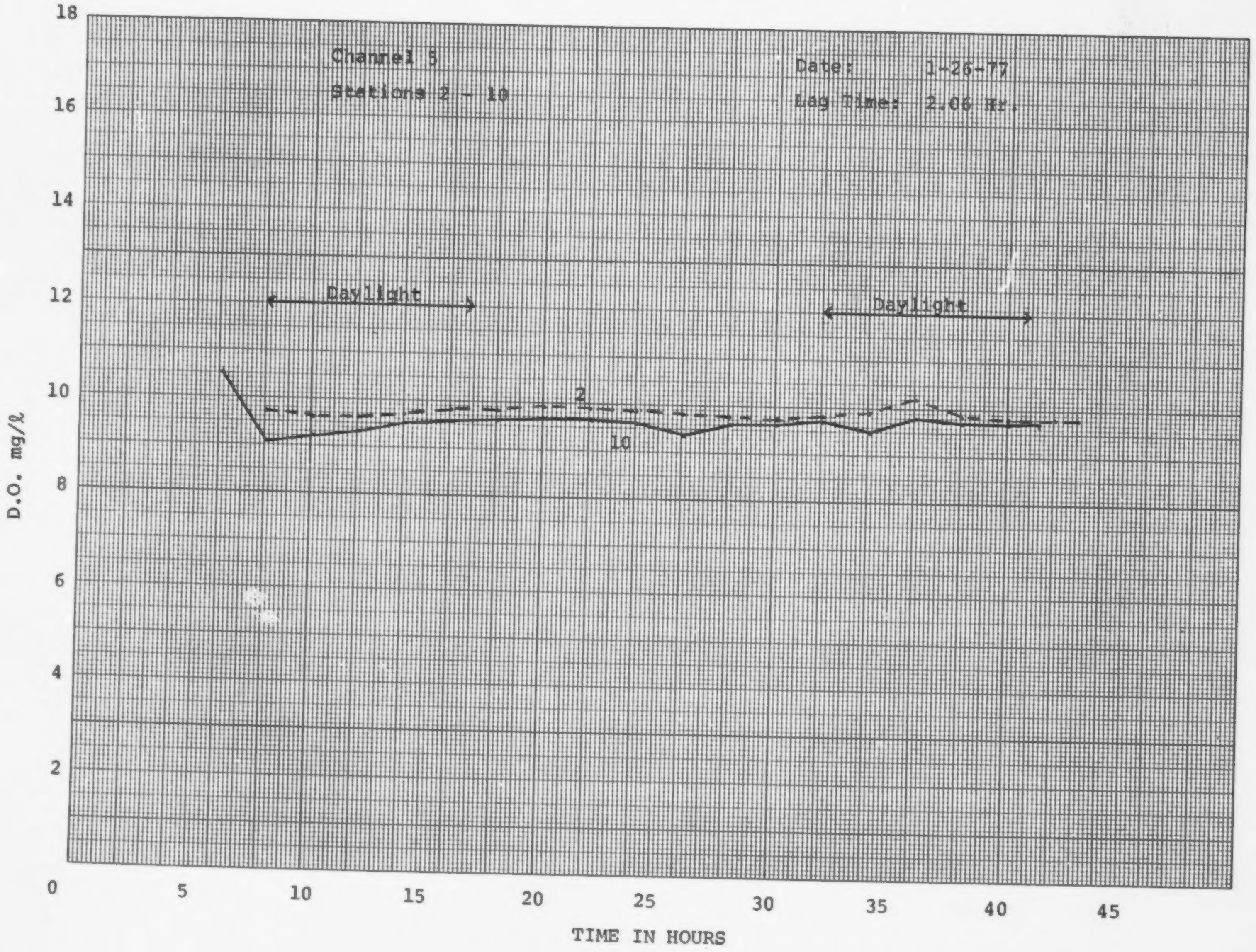

18
16
14
12
10
8
6
4
2
0
D.O. mg/ℓ
5
10
15
20
25
30
35
40
45
TIME IN HOURS
10
18
Daylight
Daylight
Channel 8
Stations 10 - 18
Date: 10-27-76
Lag Time: 2.0 Hr.

HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL
LOCATION OF REACH: Station 10 to 18 in Channel 8

Date: 10-27-76 Travel Time: 2.00 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000						
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800						
0900	0.73	0.14	0.07	0.80	0.29	
1000		1.35	0.68	1.40	0.50	
1100		2.15	1.08	1.80	0.65	
1200		2.67	1.34	2.06	0.74	
1300		2.67	1.34	2.06	0.74	
1400		2.35	1.18	1.90	0.68	
1500		2.10	1.05	1.78	0.64	
1600		1.60	0.80	1.53	0.55	
1700	0.73	0.56	0.28	1.01	0.36	
1800						
1900						
2000	0.86					
2100	0.86					
2200	0.77					
2300	0.77					
2400	0.74					$\Sigma P = 5.15\ g\ m^{-2}\ day^{-1}$
2500	0.73					$\bar{R} = 0.73\ g\ m^{-3}\ hr^{-1}$
2600	0.70					
2700	0.70					
2800	0.69					
2900	0.67					
3000	0.65					
3100	0.61					
3200	0.73	-1.10	-0.55	0.18	0.06	
3300		-0.16	-0.08	0.65	0.23	
3400		1.25	0.63	1.36	0.49	
3500		2.30	1.15	1.88	0.68	
3600		3.13	1.57	2.30	0.83	
3700		2.90	1.45	2.18	0.78	
3800		2.40	1.20	1.93	0.69	
3900		1.93	0.97	1.69	0.61	
4000		1.26	0.63	1.36	0.49	
4100	0.73	0.10	0.05	0.78	0.28	
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = 5.14\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 5
Stations 2 - 10
Date: 1-26-77
Lag Time: 2.06 Hr.
Daylight
Daylight
2
10
D.O. mg/ℓ
TIME IN HOURS
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45

HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 2 to 10 in Channel 5

Date: 1-26-77 Travel Time: 2.06 Hrs.

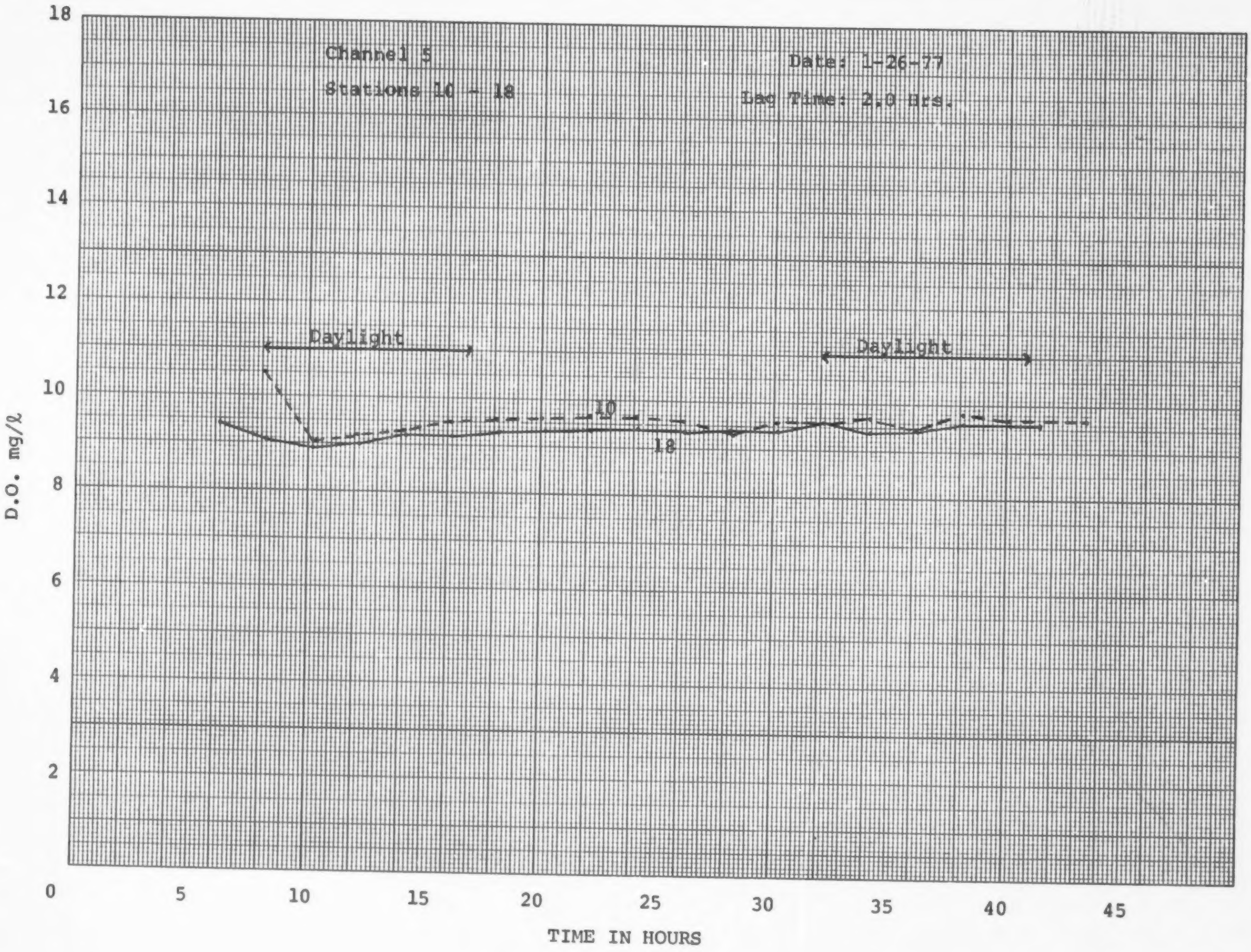
Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						1. ΔD.O. to close to determine accurate photosynthetic values.
0100						
0200						2. Same situation for 1-26-77; channel 5; Station 10 → 18.
0300						
0400						
0500						
0600						
0700						
0800 ↑	0.12	-0.55	-0.27			
0900	↓	-0.66	-0.32			
1000		-0.42	-0.20			
1100		-0.37	-0.18			
1200		-0.32	-0.16	-0.04		
1300		-0.28	-0.14			
1400		-0.21	-0.10	0.02	0.01	
1500	↓	-0.24	-0.12	-0.00	0.00	
1600 ↓	0.12	-0.24	-0.12	-0.00	0.00	
1700		-0.24	-0.12	0.00	0.00	
1800						
1900						
2000						
2100						
2200	0.12					
2300	0.14					
2400	0.13					
2500	0.16					
2600	0.21					
2700	0.16					
2800	0.09					
2900	0.06					
3000	0.04					
3100	0.05					
3200 ↑	0.12	-0.11	-0.05	0.07	0.03	
3300		-0.24	-0.12	0.00	0.00	
3400		-0.39	0.19	-0.07	-0.04	
3500						
3600						
3700						
3800						
3900						
4000 ↓						
4100						
4200						
4300						
4400						
4500						
4600						
4700						

$\Sigma P = 0.01\ g\ m^{-2}\ day^{-1}$

$\bar{R} = 0.12\ g\ m^{-3}\ hr^{-1}$

$\Sigma P = \quad g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 5
Stations 10 - 18
Date: 1-26-77
Lag Time: 2.0 Hrs.
Daylight
Daylight
10
18
D.O. mg/ℓ
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
TIME IN HOURS

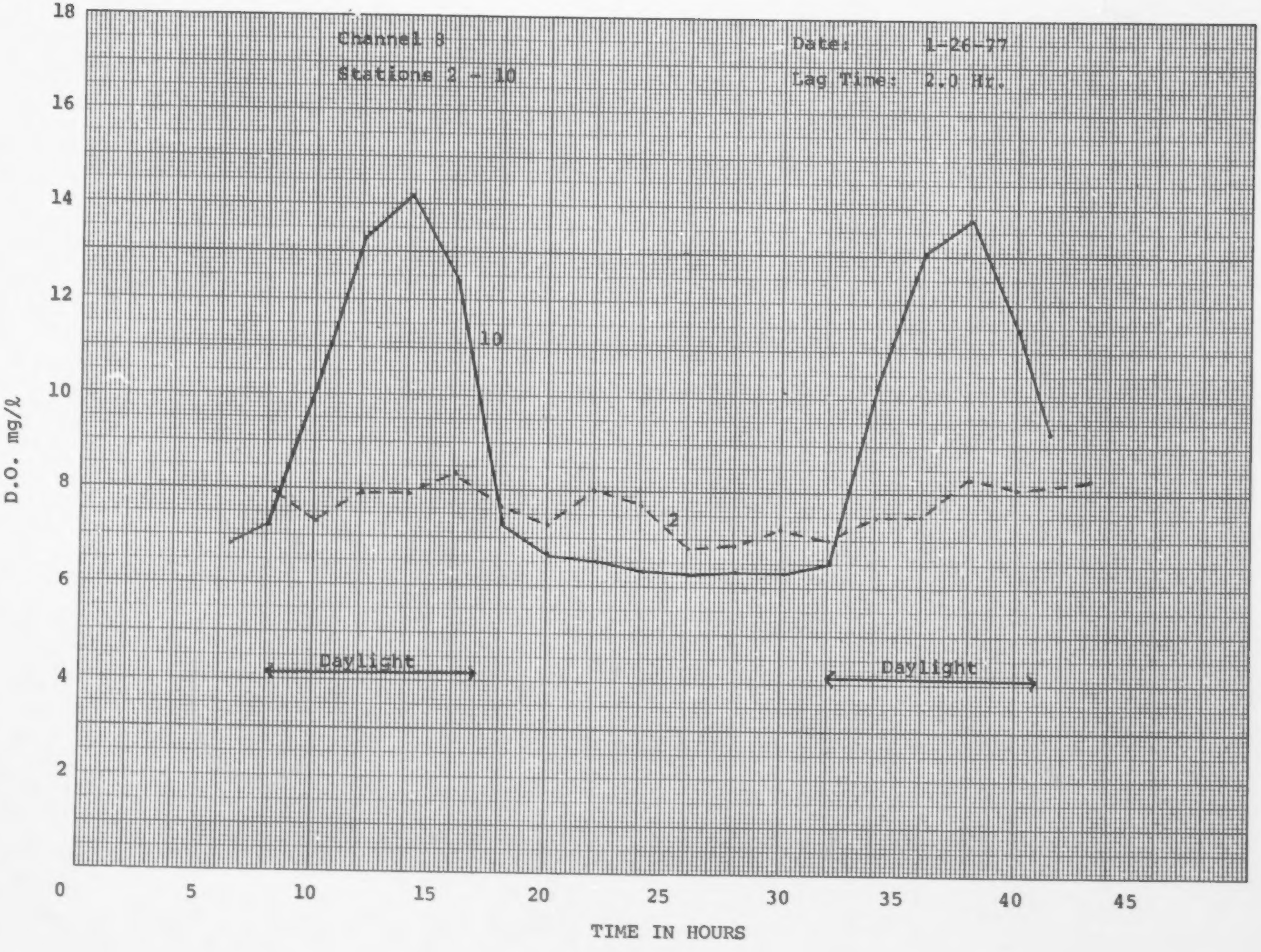
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 10 to 18 in Channel 5

Date: 1/26/77 Travel Time: 2.0 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$ *	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000						Graphical difference between upstream and downstream diel oxygen curves are insignificant to conduct meaningful analysis.
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800						
0900						
1000						
1100						
1200						
1300						
1400						
1500						
1600						
1700						
1800						
1900						
2000						
2100						
2200						
2300						
2400						
2500						
2600						
2700						
2800						
2900						
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						

**Daylight savings time.


Channel 8
Stations 2 - 10
Date: 1-26-77
Lag Time: 2.0 Hr.
10
2
Daylight
Daylight
D.O. mg/ℓ
TIME IN HOURS

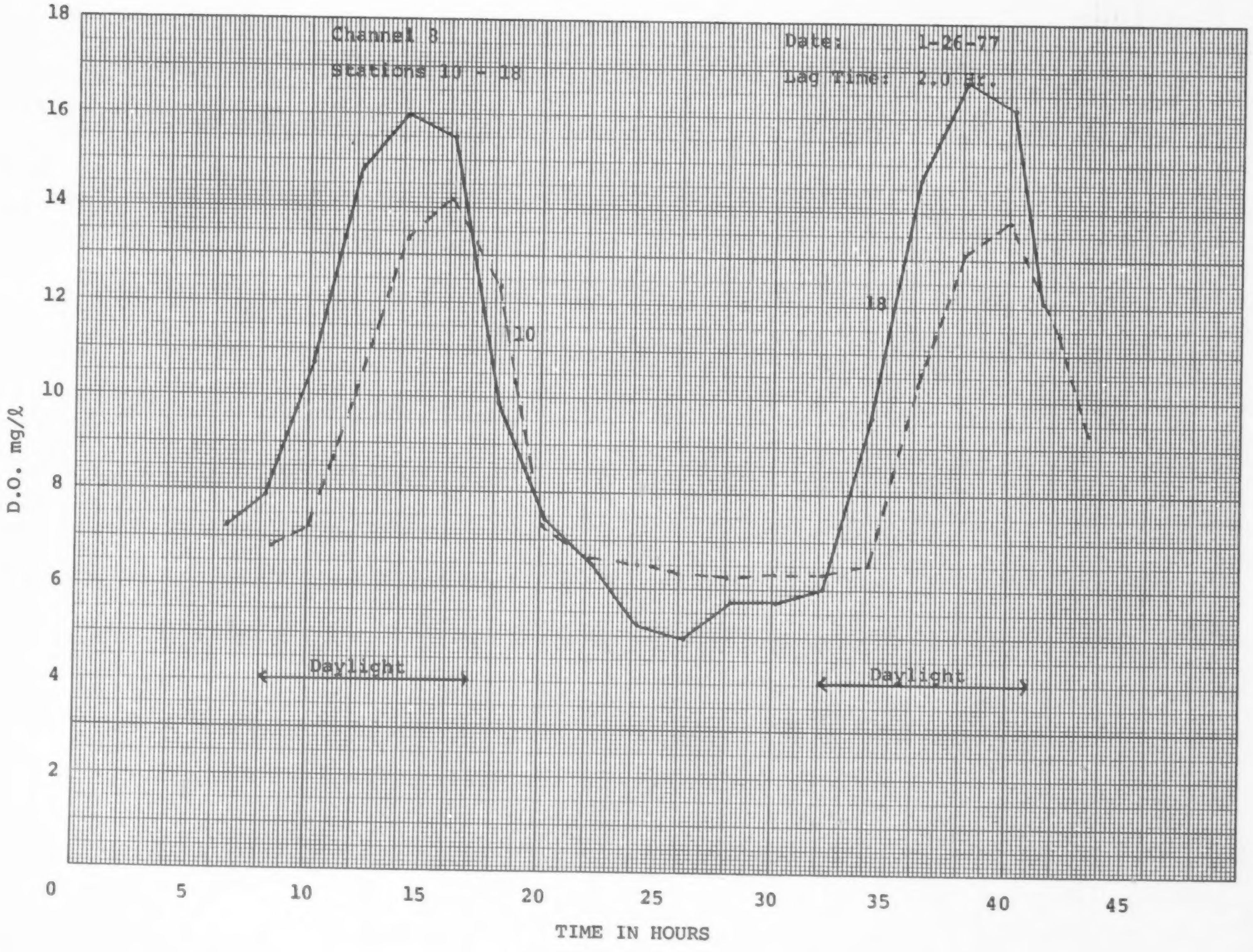
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Stations 2 to 10 in Channel 8

Date: 1-26-77 | Travel Time: 2.00 Hrs

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000						
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800						
0900	0.44	0.82	0.41	0.86	0.29	
1000		2.60	1.30	1.75	0.60	
1100		3.90	1.95	2.40	0.82	
1200		5.20	2.60	3.05	1.04	
1300		5.80	2.90	3.35	1.14	
1400		6.25	3.13	3.57	1.21	
1500		5.28	2.64	3.09	1.05	
1600		4.20	2.10	2.55	0.87	
1700	0.44	2.10	1.05	1.50	0.51	
1800						
1900	0.25					
2000	0.32					
2100	0.53					
2200	0.75					
2300	0.71					
2400	0.70					$\Sigma P = 7.53\ g\ m^{-2}\ day^{-1}$
2500	0.50					
2600	0.28					$\bar{R} = 0.44\ g\ m^{-3}\ hr^{-1}$
2700	0.29					
2800	0.29					
2900	0.35					
3000	0.45					
3100	0.36					
3200	0.44	-0.52	0.26	0.71	0.24	
3300		0.88	0.44	0.89	0.30	
3400		2.50	1.25	1.70	0.58	
3500		4.00	2.00	2.45	0.83	
3600		5.45	2.73	3.17	1.08	
3700		5.50	2.75	3.20	1.09	
3800		5.45	2.73	3.17	1.08	
3900		4.50	2.25	2.70	0.92	
4000		3.50	1.75	2.20	0.75	
4100	0.44	1.90	0.95	1.40	0.48	
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = 7.35\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 8
Stations 10 - 18
Date: 1-26-77
Lag Time: 2.0 Hr.
D.O. mg/ℓ
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45
TIME IN HOURS
10
18
Daylight
Daylight

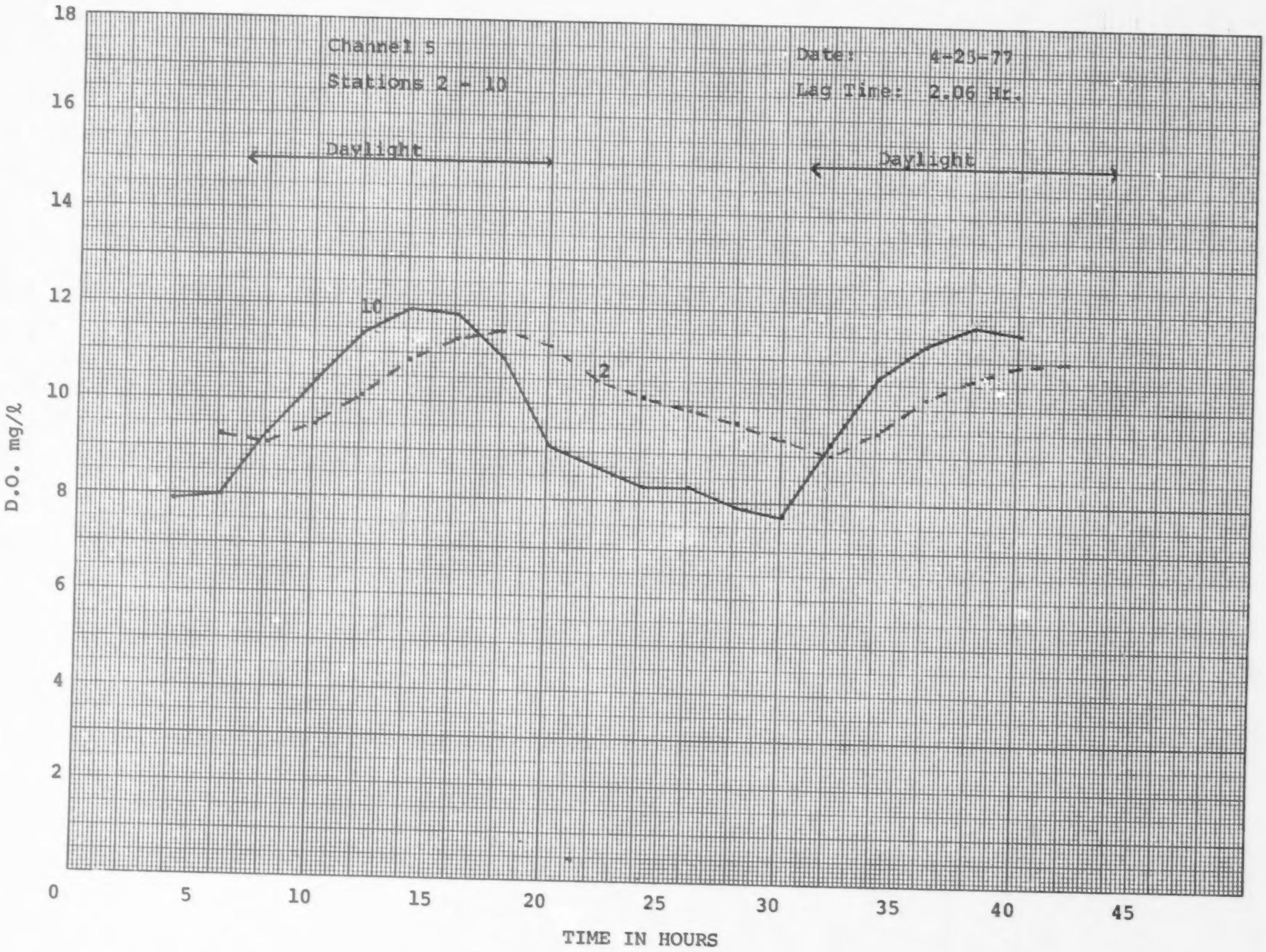
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Stations 10 to 18 in Channel 8

Date: 1/26/77 Travel Time: 2.00 Hrs

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000						
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800 ↑						
0900	0.36	2.06	1.03	1.39	0.50	
1000	↓	3.22	1.11	1.47	0.53	
1100		3.85	1.93	2.29	0.82	
1200		4.46	2.23	2.59	0.93	
1300		3.75	1.88	2.24	0.81	
1400		2.83	1.42	1.78	0.64	
1500		2.10	1.05	1.41	0.51	
1600		1.37	0.69	1.05	0.38	
1700 ↓	0.36	-0.01	-0.01	0.36	0.13	
1800						
1900	0.62					
2000	0.10					
2100	0.05					
2200	0.05					
2300	0.30					
2400	0.59					$\Sigma P = 5.25\ g\ m^{-2}\ day^{-1}$
2500	0.66					$\bar{R} = 0.36\ g\ m^{-3}\ hr^{-1}$
2600	0.66					
2700	0.50					
2800	0.31					
2900	0.29					
3000	0.30					
3100	0.25					
3200 ↑	0.36	-0.34	-0.17	0.19	0.07	
3300	↓	1.10	0.55	0.91	0.33	
3400		2.75	1.38	1.74	0.63	
3500		3.50	1.75	2.11	0.76	
3600		4.20	2.10	2.46	0.89	
3700		4.00	2.00	2.36	0.85	
3800		3.68	1.84	2.20	0.79	
3900		3.11	1.56	1.92	0.69	
4000 ↓		2.45	1.23	1.59	0.57	
4100	0.36	0.85	0.43	0.79	0.28	
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = 5.86\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.



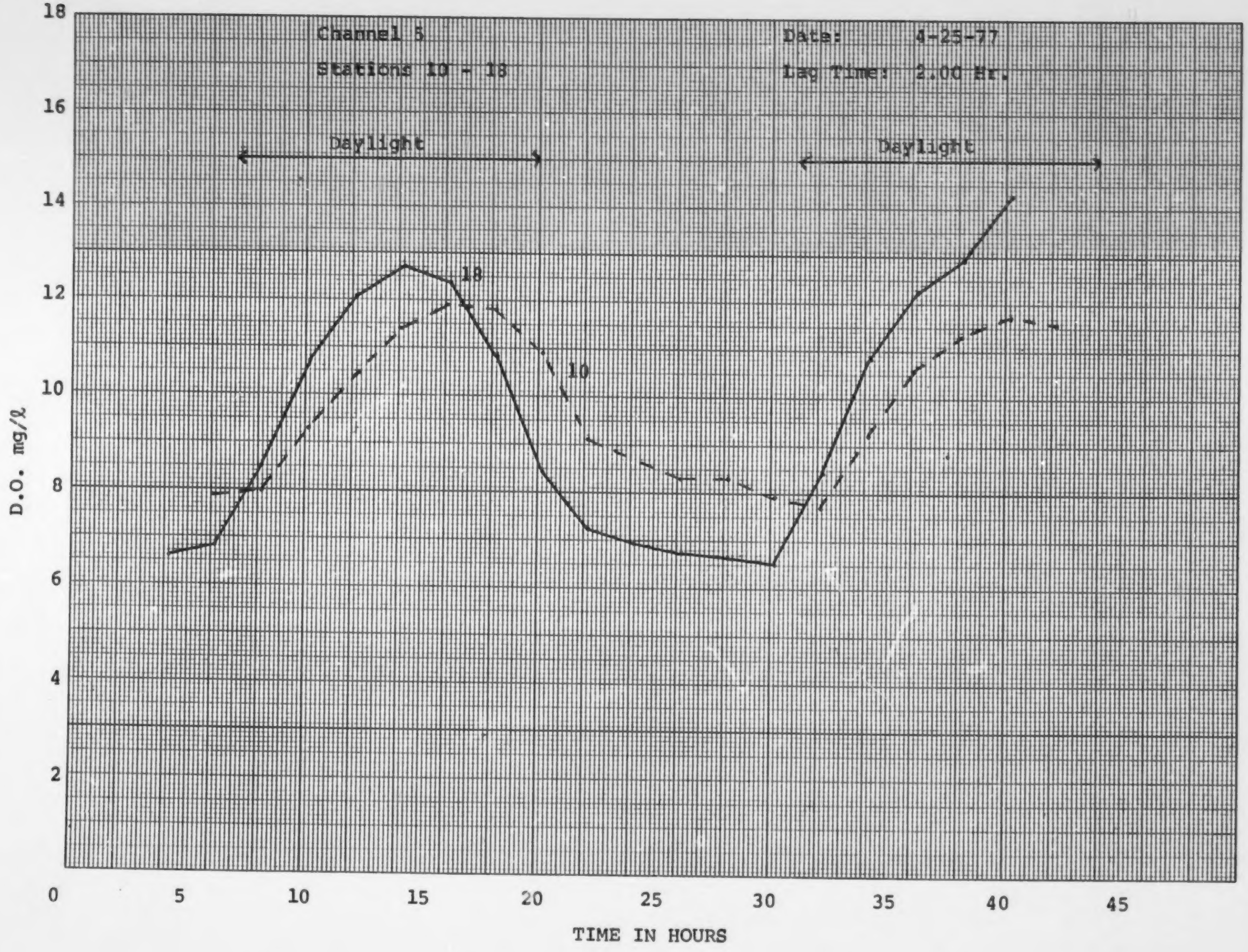
Channel 5
Stations 2 - 10
Date: 4-25-77
Lag Time: 2.06 Hr.
Daylight
Daylight
10
2
D.O. mg/ℓ
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
TIME IN HOURS

HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL
LOCATION OF REACH: Station 2 to 10 in Channel 5

Date: 4-25-77 Travel Time: 2.06 Hrs.

Time at Downstream Station (hrs)	R $g\,m^{-3}\,hr^{-1}$	ΔD.O. $g\,m^{-3}$	ΔD.O. $g\,m^{-3}\,hr^{-1}$	P $g\,m^{-3}\,hr^{-1}$	P $g\,m^{-2}\,hr^{-1}$	Comments
0000 **						
0100						
0200						
0300						
0400						
0500						
0600						
0700	0.84	-0.63	-0.37	0.53	0.18	
0800		0.12	0.06	0.90	0.31	
0900		0.49	0.24	1.08	0.37	
1000		0.81	0.39	1.23	0.42	
1100		1.05	0.51	1.35	0.46	
1200		1.26	0.61	1.45	0.49	
1300		1.17	0.57	1.41	0.48	
1400		1.06	0.51	1.35	0.46	
1500		0.83	0.40	1.24	0.42	
1600		0.55	0.27	1.11	0.38	
1700		0.05	0.02	0.86	0.29	
1800		-0.50	-0.24	0.60	0.20	
1900	0.84	-1.22	-0.59	0.25	0.09	
2000		-1.98	-0.96	-0.12		
2100						
2200	0.87					
2300	0.87					
2400	0.90					$\Sigma P = 4.55\ g\ m^{-2}\ day^{-1}$
2500	0.84					
2600	0.78					$\bar{R} = 0.84\ g\ m^{-3}\ hr^{-1}$
2700	0.81					
2800	0.85					
2900	0.82					
3000	0.78					
3100	0.84	-0.78	-0.38	0.46	0.16	
3200		0.12	0.06	0.90	0.31	
3300		0.64	0.31	1.15	0.39	
3400		1.08	0.52	1.36	0.46	
3500		1.12	0.54	1.38	0.47	
3600		1.10	0.53	1.37	0.47	
3700		1.10	0.53	1.37	0.47	
3800		1.07	0.52	1.36	0.46	
3900		0.92	0.45	1.29	0.44	
4000	0.84	0.68	0.33	1.17	0.40	
4100						
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = 4.03\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 5
Stations 10 - 18
Date: 4-25-77
Lag Time: 2.00 Hr.
Daylight
Daylight
18
10
D.O. mg/ℓ
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45
TIME IN HOURS

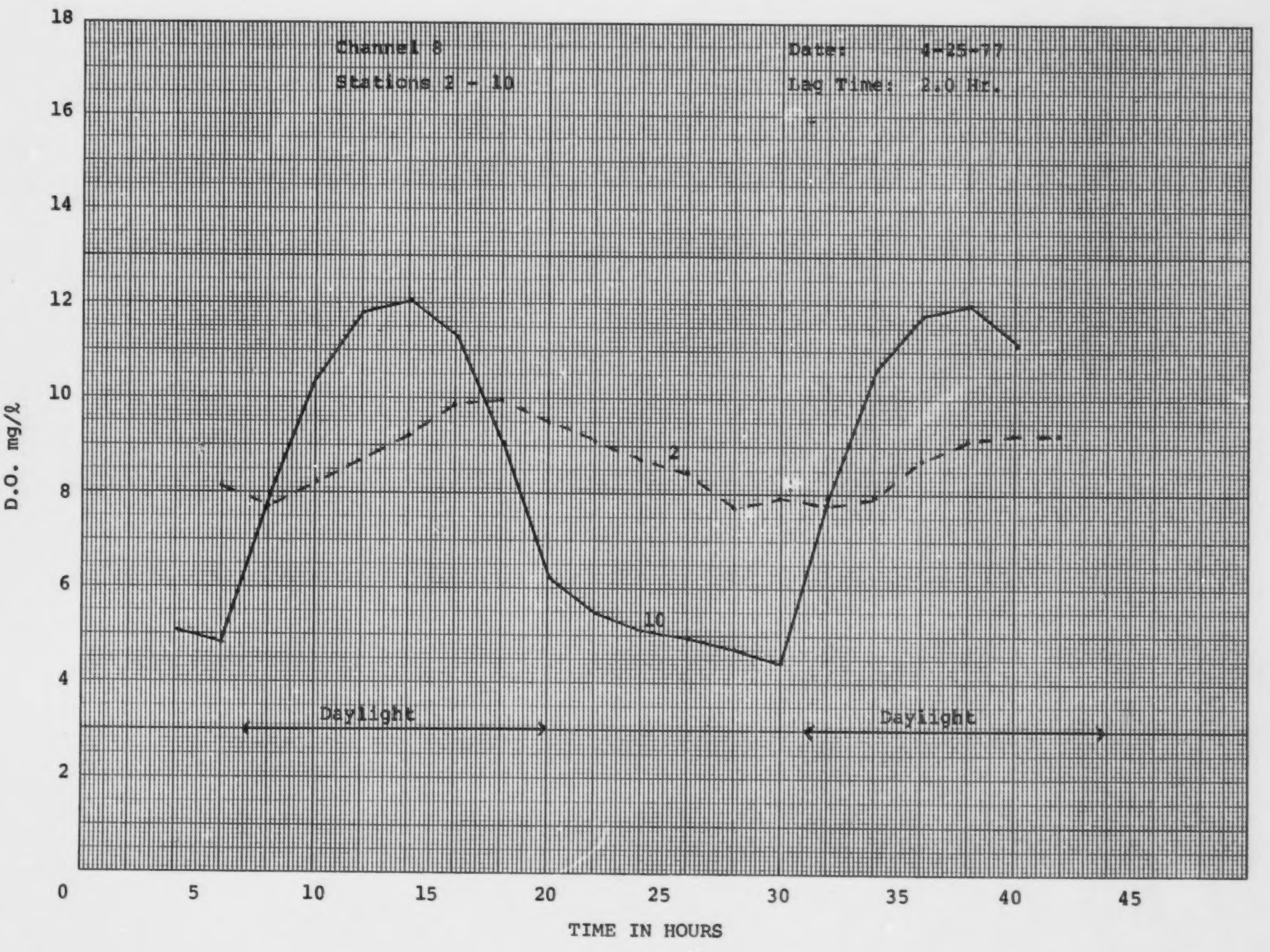
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 10 to 18 in Channel 5

Date: 4-25-77 Travel Time: 2.00 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						
0100						
0200						
0300						
0400						
0500						
0600						
0700	0.84	-0.42	-0.21	0.63	0.23	
0800		0.35	0.18	1.02	0.37	
0900		0.88	0.44	1.28	0.46	
1000		1.27	0.64	1.48	0.53	
1100		1.49	0.75	1.59	0.57	
1200		1.63	0.82	1.66	0.60	
1300		1.41	0.71	1.55	0.56	
1400		1.34	0.67	1.51	0.54	
1500		1.00	0.50	1.34	0.48	
1600		0.55	0.28	1.12	0.40	
1700		-0.07	-0.04	0.81	0.29	
1800		-0.82	-0.41	0.43	0.15	
1900	0.84	-1.51	-0.76	0.09	0.03	
2000		-2.31	-1.16	-0.32		
2100						
2200	0.94					
2300	0.91					
2400	0.88					$\Sigma P = 5.21\ g\ m^{-2}\ day^{-1}$
2500	0.83					
2600	0.79					$\bar{R} = 0.84\ g\ m^{-3}\ hr^{-1}$
2700	0.76					
2800	0.81					
2900	0.84					
3000	0.83					
3100	0.84	-0.55	-0.28	0.51	0.18	
3200		0.48	0.24	1.08	0.39	
3300		1.02	0.51	1.35	0.49	
3400		1.46	0.73	1.57	0.57	
3500		1.57	0.79	1.63	0.59	
3600		1.56	0.78	1.62	0.58	
3700		1.60	0.80	1.64	0.59	
3800		1.57	0.79	1.63	0.59	
3900		1.98	0.99	1.83	0.66	
4000	0.84	2.43	1.22	2.06	0.74	
4100						
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = 5.38\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.

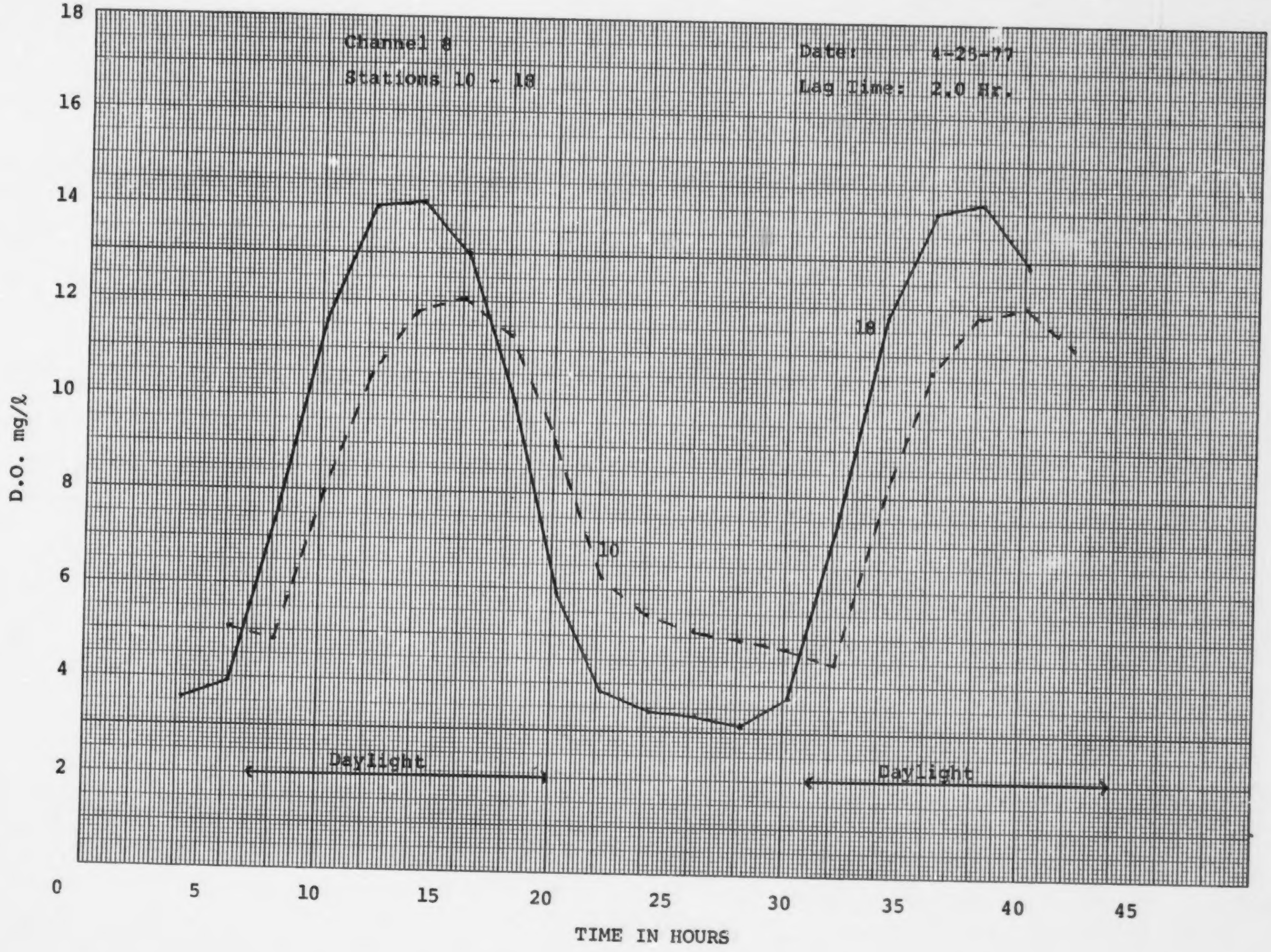

Channel 8
Stations 2 - 10
Date: 4-25-77
Lag Time: 2.0 Hr.
2
10
Daylight
Daylight
D.O. mg/ℓ
TIME IN HOURS
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45

HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL
LOCATION OF REACH: Station 2 to 10 in Channel 8

Date: 4-25-77 Travel Time: 2.00 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000						D.O. below 3 mg/ℓ were
0100						not used in computing
0200						R-value.
0300						
0400						
0500						
0600						
0700	1.72	-1.72	-0.86	0.86	0.29	
0800		0.05	0.03	1.74	0.59	
0900		1.07	0.54	2.25	0.77	
1000		2.10	1.05	2.77	0.94	
1100		2.60	1.30	3.02	1.03	
1200		3.07	1.54	3.26	1.11	
1300		2.96	1.48	3.20	1.09	
1400		2.83	1.42	3.13	1.06	
1500		2.02	1.01	2.73	0.93	
1600		1.50	1.25	2.966	1.01	
1700		-0.36	-0.18	1.54	0.52	
1800		-0.64	-0.32	1.40	0.48	
1900	1.72	-1.86	-0.93	0.79	0.27	
2000						
2100						
2200	1.81					
2300	1.81					
2400	1.81					$\Sigma P = 10.09\ g\ m^{-2}\ day^{-1}$
2500	1.79					
2600	1.74					$\bar{R} = 1.72\ g\ m^{-3}\ hr^{-1}$
2700	1.63					
2800	1.49					
2900	1.62					
3000	1.74					
3100	1.72	-1.82	-0.91	0.81	0.28	
3200		0.00	0.80	1.72	0.58	
3300		1.23	0.62	2.33	0.79	
3400		2.55	1.275	2.991	1.02	
3500		2.80	1.40	3.12	1.06	
3600		3.00	1.50	3.22	1.09	
3700		2.96	1.48	3.20	1.09	
3800		2.88	1.44	3.16	1.07	
3900		2.44	1.22	2.936	1.00	
4000	1.72	2.00	1.00	2.72	0.92	
4100						
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = 8.90\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 8
Stations 10 - 18
Date: 4-25-77
Lag Time: 2.0 Hr.
D.O. mg/ℓ
TIME IN HOURS
Daylight
Daylight
10
18
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45

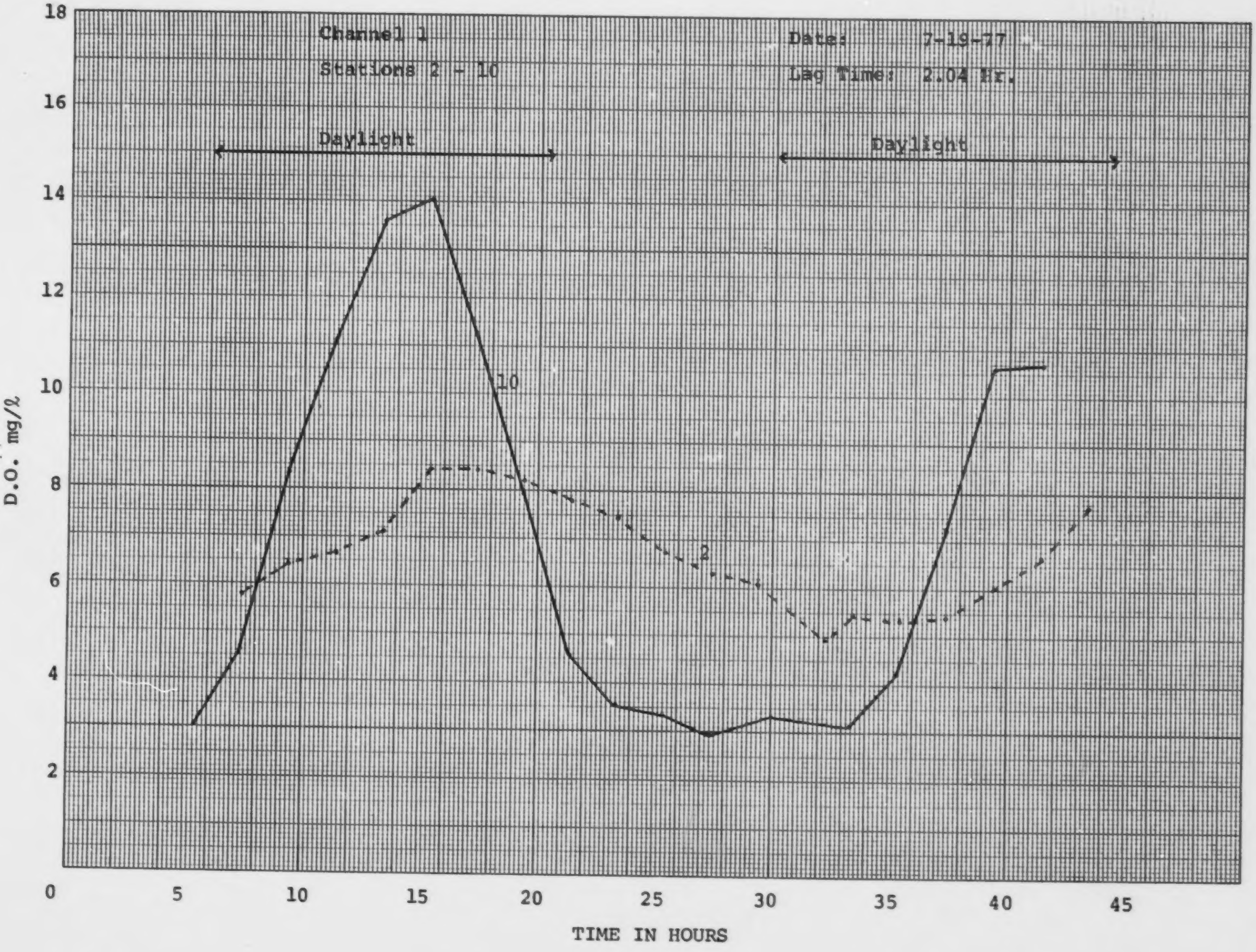
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 10 to 18 in Channel 8

Date: 4-25-77 Travel Time: 2.00 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000						
0100						
0200						
0300						
0400						
0500						
0600						
0700 ↑	0.92	0.37	0.19	1.11	0.40	
0800	↓	2.32	1.16	2.08	0.75	
0900		2.95	1.48	2.40	0.86	
1000		3.40	1.70	2.62	0.94	
1100		3.45	1.73	2.65	0.95	
1200		3.45	1.73	2.65	0.95	
1300		3.04	1.52	2.44	0.88	
1400		2.28	1.14	2.06	0.74	
1500		1.78	0.89	1.81	0.65	
1600		1.10	0.55	1.47	0.53	
1700		0.16	0.08	1.00	0.36	
1800		-0.96	-0.48	0.44	0.16	
1900 ↓	0.92	-1.80	-0.90	0.02	0.01	
2000						
2100						
2200	1.20					
2300	1.10					
2400	1.03					$\Sigma P = 8.18\ g\ m^{-2}\ day^{-1}$
2500	0.98					
2600	0.90					$\bar{R} = 0.92\ g\ m^{-3}\ hr^{-1}$
2700	0.90					
2800	0.90					
2900	0.75					
3000	0.55					
3100 ↑	0.92	0.56	0.28	1.20	0.43	
3200	↓	2.56	1.28	2.20	0.79	
3300		3.25	1.63	2.55	0.92	
3400		3.60	1.80	2.72	0.98	
3500		3.55	1.78	2.70	0.97	
3600		3.30	1.65	2.57	0.93	
3700		2.93	1.47	2.39	0.86	
3800		2.43	1.22	2.14	0.77	
3900		1.80	0.90	1.82	0.66	
4000	0.92	1.00	0.50	1.42	0.51	
4100						
4200						
4300 ↓						
4400						
4500						
4600						
4700						$\Sigma P = 7.82\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.

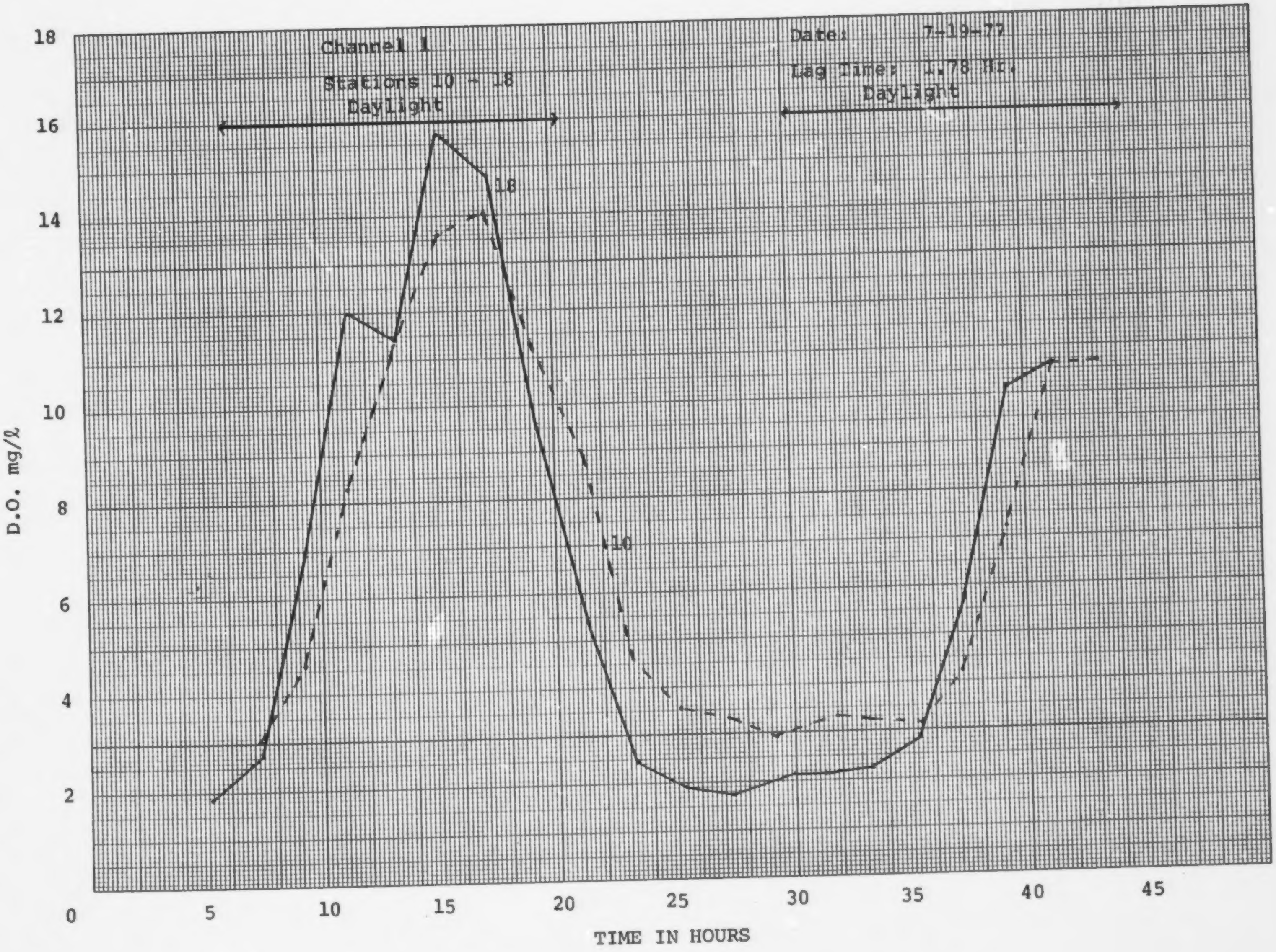

Channel 1
Stations 2 - 10
Date: 7-19-77
Lag Time: 2.04 Hr.
Daylight
Daylight
10
2
D.O. mg/ℓ
TIME IN HOURS
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45

HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL
LOCATION OF REACH: Station 2 to 10 in Channel 1

Date: 7-19-77 Travel Time: 2.04 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000						
0100						
0200						
0300						
0400						
0500						
0600						
0700	1.63	-1.14	-0.56	1.07	0.43	
0800		0.45	0.22	1.85	0.74	
0900		1.96	0.96	2.59	1.04	
1000		3.12	1.53	3.16	1.26	
1100		4.35	2.13	3.76	1.50	
1200		5.32	2.61	4.24	1.70	
1300		6.34	3.11	4.74	1.90	
1400		5.96	2.92	4.55	1.82	
1500		5.57	2.73	4.36	1.74	
1600		4.10	2.01	3.64	1.46	
1700		2.63	1.29	2.92	1.17	
1800		1.16	0.57	2.20	0.88	
1900		-0.29	-0.14	1.49	0.60	
2000		-1.75	-0.86	0.77	0.31	
2100	1.63	-3.22	-1.58	0.55	0.02	
2200	1.63					
2300						
2400						$\Sigma P = 16.57\ g\ m^{-2}\ day^{-1}$
2500						
2600						$R = 1.63\ g\ m^{-3}\ hr^{-1}$
2700						
2800						
2900						
3000	1.63	-2.65	-1.30	0.33	0.13	
3100		-2.54	-1.25	0.38	0.15	
3200		-2.43	-1.19	0.44	0.18	
3300		-2.30	-1.13	0.50	0.20	
3400		-1.70	-0.83	0.80	0.32	
3500		-1.10	-0.54	1.09	0.44	
3600		0.33	0.16	1.79	0.72	
3700		1.80	0.88	2.51	1.00	
3800		3.19	1.56	3.19	1.28	
3900		4.58	2.24	3.88	1.55	
4000		4.30	2.11	3.74	1.50	
4100	1.63	4.05	1.98	3.62	1.45	
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = 8.92\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.



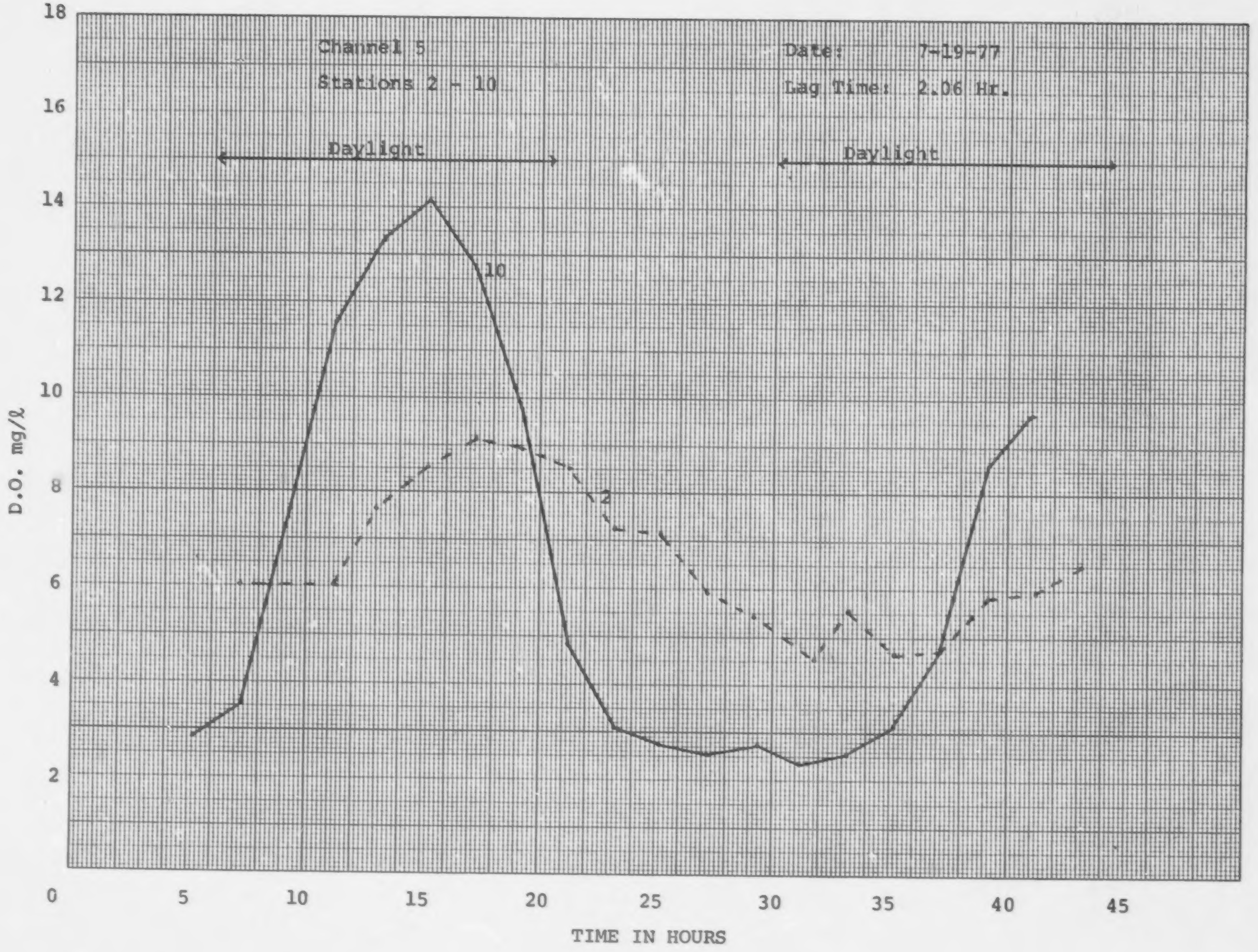
Channel 1
Stations 10 - 18
Daylight
Date: 7-19-77
Lag Time: 1.78 Hr.
Daylight
18
10
D.O. mg/ℓ
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
TIME IN HOURS

HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL
ON OF REACH: Stations 10 to 18 in Channel 1

Date: 7-19-77 Travel Time: 1.78 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000						
0100						
0200						
0300						
0400						
0500						
0600						
0700	0.53	-0.48	-0.27	0.27	0.10	
0800	1.02	0.20	0.11	1.13	0.43	
0900		1.41	0.79	1.82	0.69	
1000		1.99	1.12	2.14	0.81	
1100		2.62	1.47	2.49	0.95	
1200		2.94	1.65	2.68	1.02	
1300		2.51	1.41	2.44	0.93	
1400		2.24	1.26	2.28	0.87	
1500		1.94	1.09	2.11	0.80	
1600		1.73	0.97	1.99	0.76	
1700		1.03	0.58	1.60	0.61	
1800		0.59	0.33	1.35	0.51	
1900		-0.59	-0.33	0.70	0.27	
2000		-1.26	-0.71	0.32	0.12	
2100	1.02	-1.73	-0.97	0.05	0.02	
2200						
2300						
2400						$\Sigma P = 8.89\ g\ m^{-2}\ day^{-1}$
2500						
2600						$R = 1.02\ g\ m^{-3}\ hr^{-1}$
2700						
2800						
2900						
3000	1.02	-1.14	-0.64	0.38	0.14	
3100		-1.13	-0.64	0.38	0.14	
3200		-1.06	-0.60	0.42	0.16	
3300		-1.01	-0.57	0.45	0.17	
3400		-0.79	-0.44	0.58	0.22	
3500		-0.43	-0.24	0.78	0.30	
3600		0.00	0.00	1.02	0.39	
3700		0.95	0.53	1.55	0.59	
3800		1.45	0.82	1.84	0.70	
3900		2.13	1.20	2.22	0.84	
4000		1.67	0.94	1.96	0.74	
4100	1.02	0.18	0.10	1.12	0.43	
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = 4.82\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.

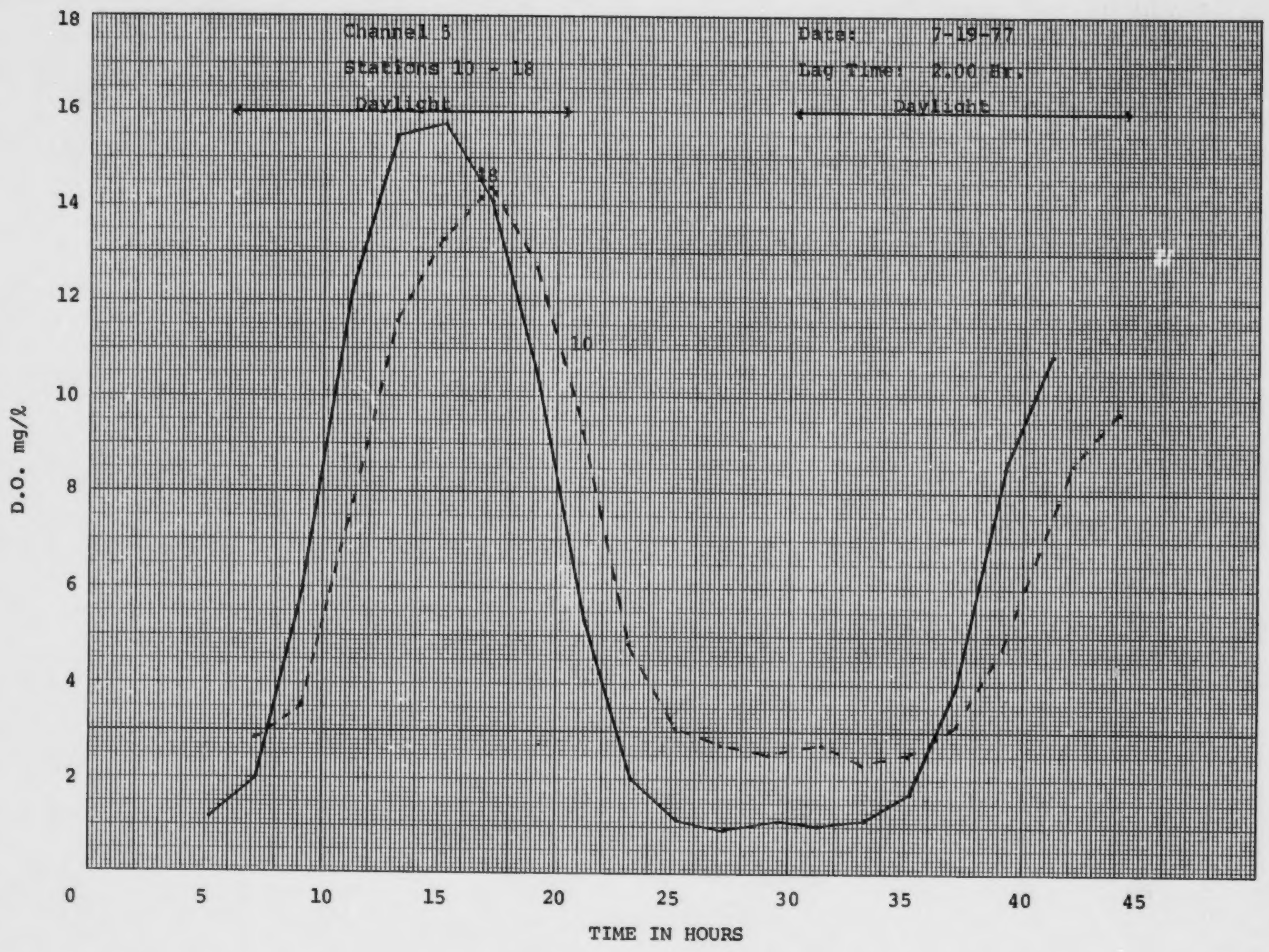

Channel 5
Stations 2 - 10
Date: 7-19-77
Lag Time: 2.06 Hr.
Daylight
Daylight
10
2
D.O. mg/ℓ
TIME IN HOURS
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45

HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL
LOCATION OF REACH: Station 2 to 10 in Channel 5

Date: 7-19-77 Travel Time: 2.06

Time at Downstream Station (hrs)		R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000							D.O. below 3 mg/ℓ were not used in computing the R-values.
0100							
0200							
0300							
0400							
0500							
0600	↑	2.00					
0700	│	│	-2.60	-1.26	0.70	0.28	
0800	│	│	-0.95	-0.46	1.54	0.59	
0900	│	│	1.05	0.51	2.51	0.95	
1000	│	│	2.35	1.14	3.14	1.19	
1100	│	│	3.65	1.77	3.77	1.43	
1200	│	│	4.24	2.06	4.06	1.54	
1300	│	│	4.70	2.28	4.28	1.63	
1400	│	│	4.88	2.37	4.37	1.66	
1500	│	│	4.99	2.42	4.42	1.68	
1600	│	│	4.55	2.21	4.21	1.60	
1700	│	│	3.98	1.93	3.93	1.49	
1800	│	│	2.64	1.28	3.28	1.25	
1900	│	│	1.07	0.52	2.52	0.96	
2000	↓	│	-0.45	-0.22	1.78	0.68	
2100		↓	-2.00	-0.97	1.03	0.39	
2200		2.00	-3.17	-1.54	0.46	0.17	
2300		1.98					
2400		2.14					$\Sigma P = 17.49\ g\ m^{-2}\ day^{-1}$
2500							
2600							$\bar{R} = 2.00\ g\ m^{-3}\ hr^{-1}$
2700							
2800							
2900							
3000	↑	2.00	-2.62	-1.27	0.73	0.28	
3100	│	│	-2.41	-1.17	0.83	0.32	
3200	│	│	-2.02	-0.98	1.02	0.39	
3300	│	│	-1.51	-0.73	1.27	0.48	
3400	│	│	-0.90	-0.44	1.56	0.59	
3500	│	│	-0.10	-0.05	1.95	0.74	
3600	│	│	1.10	0.53	2.53	0.96	
3700	│	│	2.50	1.21	3.21	1.22	
3800	│	↓	3.19	1.55	3.55	1.35	
3900	│	2.00	3.70	1.80	3.80	1.44	
4000	│						
4100	│						
4200	│						
4300	│						
4400	↓						
4500							
4600							
4700							$\Sigma P = 7.77\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 5
Stations 10 - 18
Daylight
Date: 7-19-77
Lag Time: 2.00 Hr.
Daylight
18
10
D.O. mg/ℓ
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
TIME IN HOURS

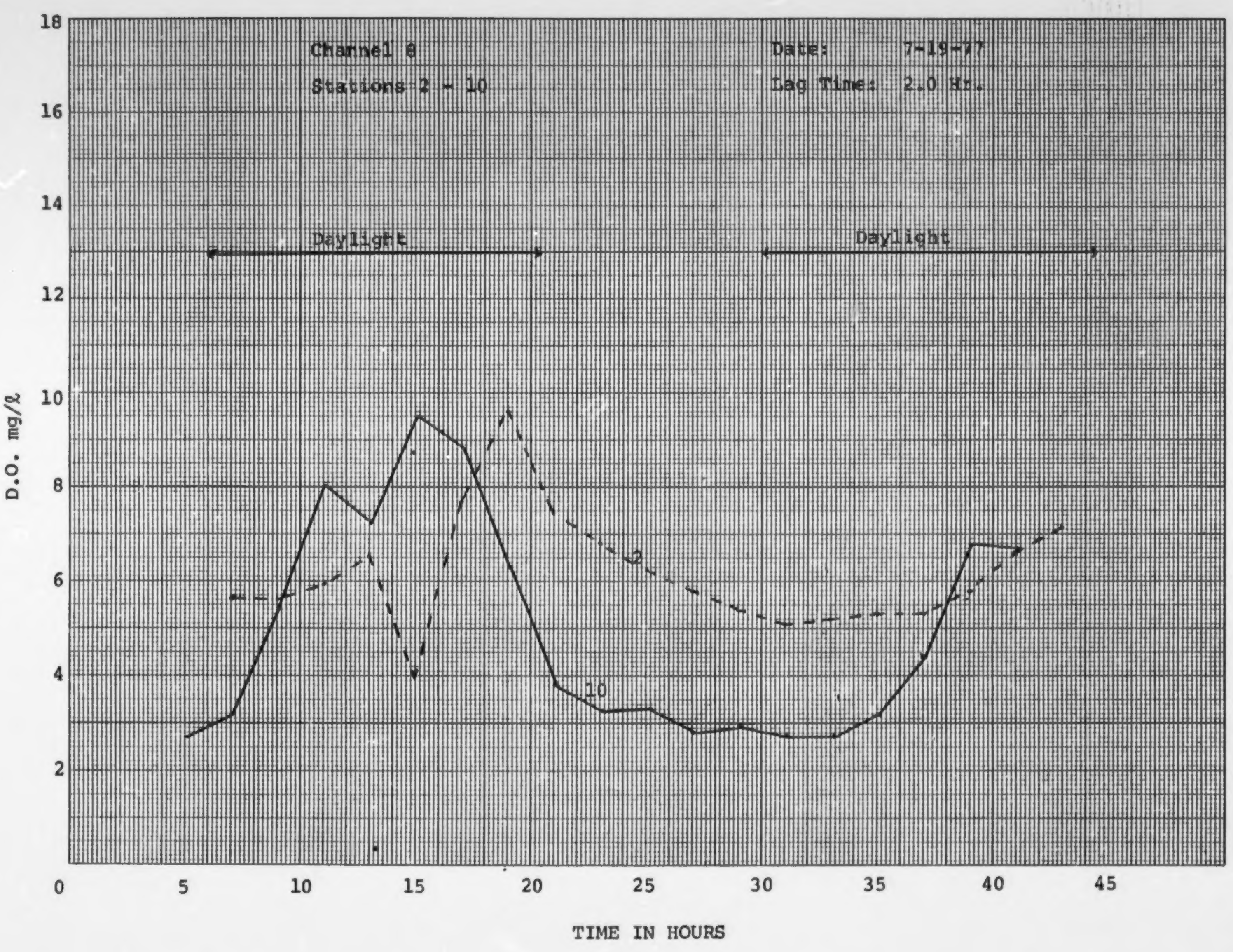
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Stations 10 to 18 in Channel 5

Date: 7-19-77 Travel Time: 2.00 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000						D.O. below 3 mg/ℓ were not used in computing the R-value.
0100						
0200						
0300						
0400						
0500						
0600	1.70					
0700		-0.94	-0.47	1.23	0.46	
0800		-0.22	-0.11	1.59	0.59	
0900		1.86	0.93	2.63	0.97	
1000		2.76	1.38	3.08	1.14	
1100		3.90	1.95	3.65	1.35	
1200		4.06	2.03	3.73	1.38	
1300		3.60	1.80	3.50	1.30	
1400		3.30	1.65	3.35	1.24	
1500		2.52	1.26	2.96	1.10	
1600		1.60	0.80	2.50	0.93	
1700		0.40	0.20	1.90	0.70	
1800	1.70	-0.60	-0.30	1.40	0.52	
1900				0.77	0.28	
2000				0.41	0.15	
2100						
2200	1.70					
2300						
2400						$\Sigma P = 12.11\ g\ m^{-2}\ day^{-1}$
2500						
2600						$\bar{R} = 1.70\ g\ m^{-3}\ hr^{-1}$
2700						
2800						
2900						
3000	1.70	-1.44	-0.72	0.98	0.36	
3100		-1.66	-0.83	0.87	0.32	
3200		-1.49	-0.74	0.96	0.36	
3300		-1.26	-0.63	1.07	0.40	
3400		-1.09	-0.54	1.16	0.43	
3500		-0.89	-0.44	1.26	0.47	
3600		-0.30	-0.15	1.55	0.57	
3700		0.56	0.28	1.98	0.73	
3800		1.67	0.84	2.54	0.94	
3900		3.07	1.54	3.24	1.20	
4000		2.86	1.43	3.13	1.16	
4100	1.70	2.16	1.08	2.78	1.03	
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = 7.97\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 8
Stations 2 - 10
Date: 7-19-77
Lag Time: 2.0 Hr.
Daylight
Daylight
2
10
D.O. mg/ℓ
TIME IN HOURS

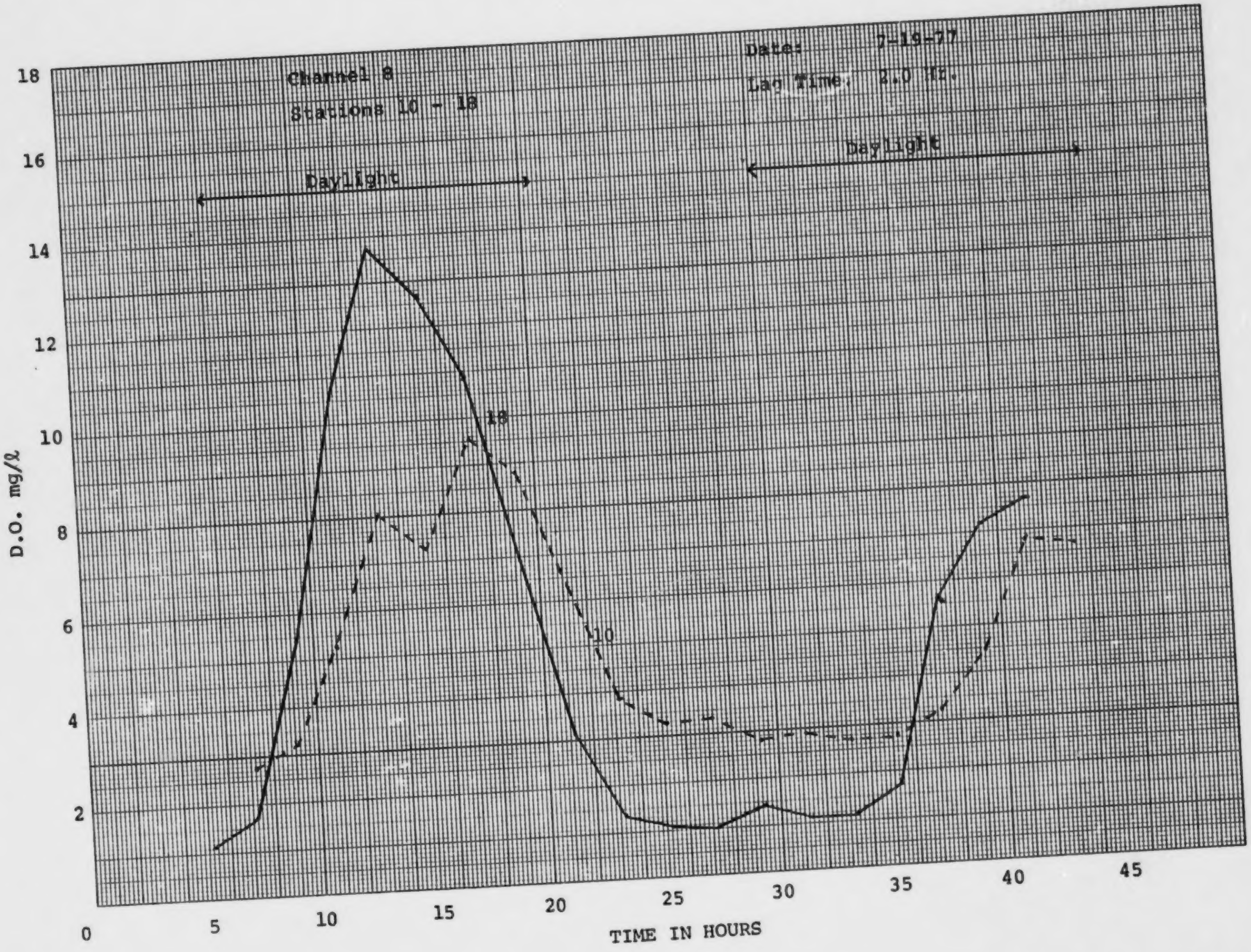
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Stations 2 to 10 in Channel 8

Date: 7-19-77 Travel Time: 2.00 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000						1) Depletion in D.O. during the day occurs in both curves.
0100						
0200						
0300						2) D.O. values below 3 mg/ℓ not used in computing respiration rates.
0400						
0500						
0600 ↑	1.58					
0700	↓	-2.50	-1.25	0.33	0.13	
0800		-1.35	-0.68	0.90	0.36	
0900		-0.35	-0.18	1.41	0.56	
1000		0.81	0.41	1.99	0.80	
1100		2.00	1.00	2.58	1.03	
1200		1.50	0.75	2.33	0.98	
1300		0.78	0.39	1.97	0.97	
1400		2.90	1.45	3.03	1.21	
1500		5.40	2.70	4.28	1.71	
1600		3.40	1.70	3.28	1.31	
1700		1.22	0.61	2.19	0.88	
1800		-0.85	-0.43	1.16	0.46	
1900	↓	-3.10	-1.55	0.03	0.01	
2000 ↓	1.58	-3.30	-1.65			
2100						
2200						
2300	1.76					
2400	1.62					$\Sigma P = 10.41\ g\ m^{-2}\ day^{-1}$
2500	1.47					
2600	1.47					$\bar{R} = 1.58\ g\ m^{-3}\ hr^{-1}$
2700						
2800						
2900						
3000 ↑	1.58	-2.45	-1.23	0.36	0.14	
3100	↓	-2.40	-1.20	0.38	0.15	
3200		-2.43	-1.22	0.37	0.15	
3300		-2.50	-1.25	0.33	0.13	
3400		-2.35	-1.18	0.41	0.16	
3500		-2.15	-1.08	0.51	0.20	
3600		-1.60	-0.80	0.78	0.31	
3700		-1.00	-0.50	1.08	0.43	
3800		-0.10	-0.05	1.53	0.61	
3900		0.84	0.42	2.00	0.80	
4000	↓	0.56	0.28	1.86	0.74	
4100	1.58	0.12	0.06	1.64	0.66	
4200						
4300						
4400 ↓						
4500						
4600						
4700						$\Sigma P = 4.48\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 8
Stations 10 - 18
Date: 7-19-77
Lag Time: 2.0 Hr.
Daylight
Daylight
18
10
D.O. mg/ℓ
0
2
4
6
8
10
12
14
16
18
5
15
20
25
30
35
40
45
TIME IN HOURS

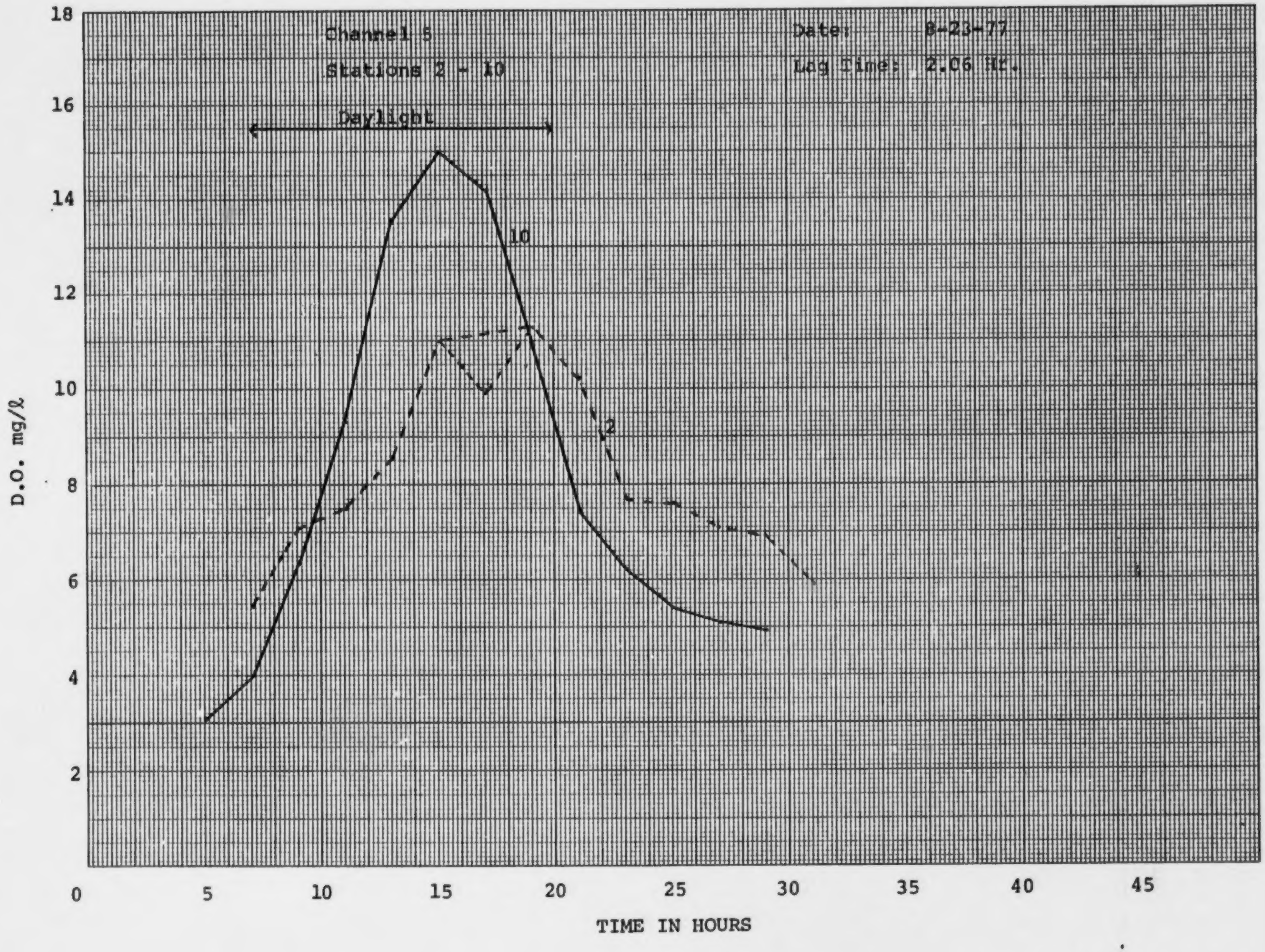
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Stations 10 to 18 in Channel 8

Date: 7-19-77 Travel Time: 2.00 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000						1) D.O. values below 3 mg/ℓ would not be used in computing respiration rate due to D.O. limitation.
0100						2) Respiration rate assumed same upstream as downstream.
0200						
0300						
0400						
0500						
0600	1.58					
0700						
0800		0.20	0.10	1.68	0.64	
0900		1.80	0.80	2.48	0.94	
1000		3.10	1.55	3.13	1.19	
1100		4.70	2.35	3.93	1.49	
1200		5.25	2.63	4.21	1.60	
1300		5.50	2.75	4.33	1.65	
1400		5.66	2.83	4.41	1.68	
1500		5.50	2.75	4.33	1.65	
1600		3.80	1.90	3.48	1.32	
1700		1.70	0.85	2.43	0.92	
1800		0.05	0.03	1.61	0.61	
1900		-1.55	-0.78	0.81	0.31	
2000	1.58	-2.35	-1.175	0.41	0.16	
2100						
2200						
2300						
2400						$\Sigma P = 14.16\ g\ m^{-2}\ day^{-1}$
2500						
2600						$\bar{R} = 1.58\ g\ m^{-3}\ hr^{-1}$
2700						
2800						
2900						
3000	1.58	-1.54	-0.77	0.81	0.31	
3100		-1.77	-0.89	0.69	0.26	
3200		-1.70	-0.85	0.73	0.28	
3300		-1.60	-0.80	0.78	0.30	
3400		-1.40	-0.70	0.88	0.33	
3500		-1.07	-0.54	1.05	0.40	
3600		0.25	0.13	1.71	0.65	
3700		2.00	1.00	2.58	0.98	
3800		2.45	1.23	2.81	1.07	
3900		2.65	1.33	2.91	1.11	
4000		1.95	0.98	2.56	0.97	
4100	1.58	0.95	0.48	2.06	0.78	
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P = 7.44\ g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 5
Stations 2 - 10
Date: 8-23-77
Lag Time: 2.06 Hr.
Daylight
10
2
D.O. mg/ℓ
TIME IN HOURS
0
5
10
15
20
25
30
35
40
45
2
4
6
8
10
12
14
16
18

HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Stations 2 to 10 in Channel 5

Date: 8-23-77 Travel Time: 2.06 Hrs

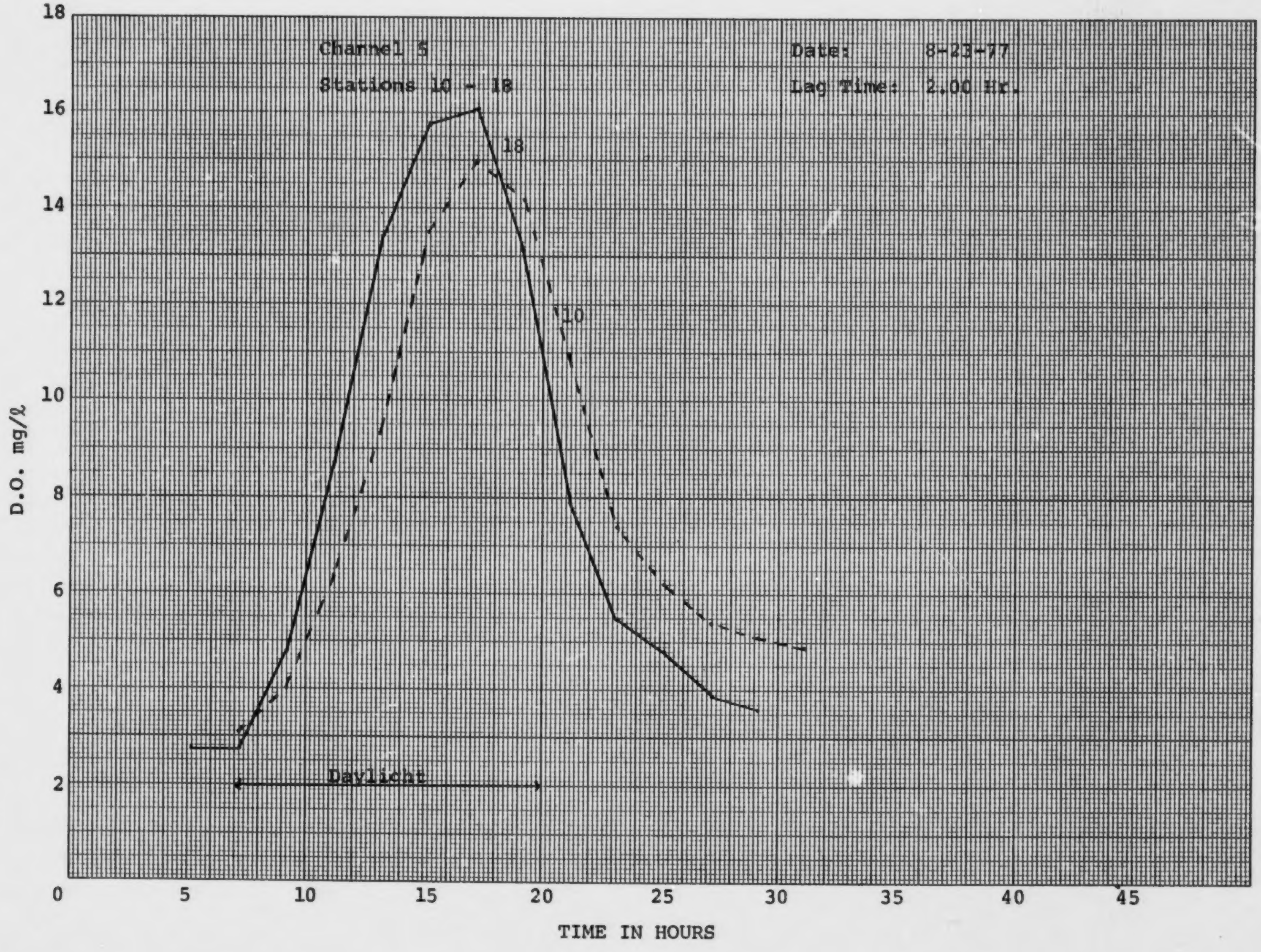
Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$ *	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000						1) D.O. error in Station 2
0100						1610 Hrs.
0200						
0300						
0400						
0500						
0600						
0700						
0800	1.06	-1.16	-0.56	0.50	0.19	
0900		-0.81	-0.39	0.67	0.25	
1000		0.35	0.17	1.23	0.47	
1100		1.70	0.83	1.89	0.72	
1200		3.22	1.56	2.62	1.00	
1300		4.82	2.34	3.40	1.29	
1400		4.53	2.20	3.26	1.24	
1500		4.07	1.98	3.04	1.16	
1600		3.61	1.75	2.81	1.07	
1700		3.11	1.51	2.57	0.98	
1800		1.61	0.78	1.84	0.70	
1900		-0.12	-0.06	1.00	0.38	
2000	1.06	-1.42	-0.69	0.37	0.14	
2100						
2200	1.12					
2300	1.31					
2400	0.90					
2500	1.08					
2600	1.06					
2700	1.02					
2800	1.01					
2900	1.01					
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						

$\Sigma P = 9.59\ g\ m^{-2}\ day^{-1}$

$\bar{R} = 1.06\ g\ m^{-3}\ hr^{-1}$

$\Sigma P = \quad g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 5
Stations 10 - 18
Date: 8-23-77
Lag Time: 2.00 Hr.
18
10
Daylight
D.O. mg/ℓ
0
2
4
6
8
10
12
14
16
18
5
15
20
25
30
35
40
45
TIME IN HOURS

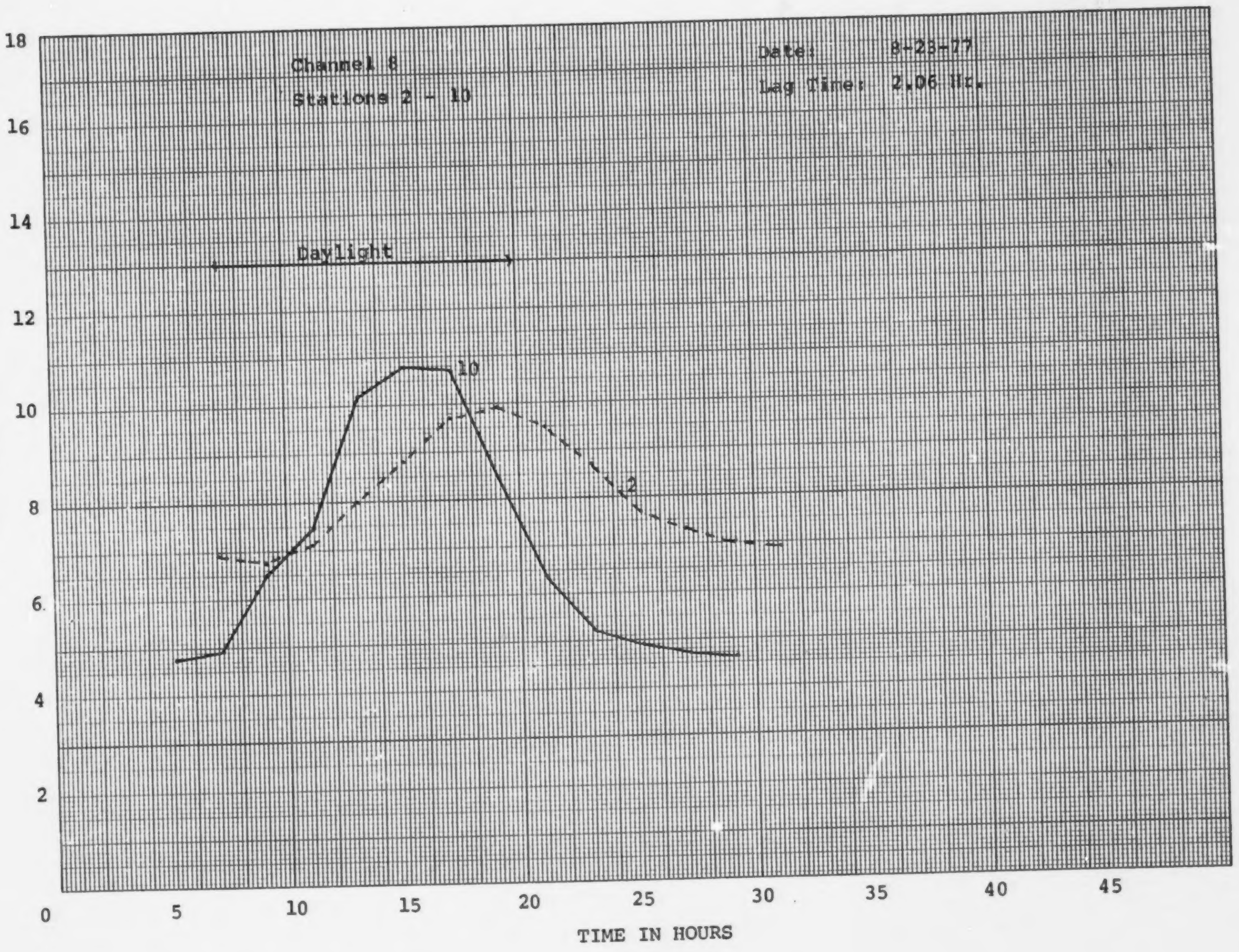
HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Stations 10 to 18 in Channel 5

Date: 8-23-77 Travel Time: 2.00 Hrs.

Time at Downstream Station (hrs)	R $g\,m^{-3}\,hr^{-1}$	ΔD.O. $g\,m^{-3}$	ΔD.O. $g\,m^{-3}\,hr^{-1}$	P $g\,m^{-3}\,hr^{-1}$	P $g\,m^{-2}\,hr^{-1}$	Comments
0000 **						
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800	0.86	0.60	0.30	1.16	0.43	
0900		0.64	0.32	1.18	0.44	
1000		1.38	0.69	1.55	0.57	
1100		2.20	1.10	1.96	0.73	
1200		2.95	1.48	2.34	0.87	
1300		3.75	1.88	2.74	1.01	
1400		3.21	1.61	2.47	0.91	
1500		2.29	1.15	2.01	0.74	
1600		1.78	0.89	1.75	0.65	
1700		1.21	0.61	1.47	0.54	
1800		0.25	0.13	0.99	0.37	
1900		-0.85	-0.43	0.44	0.16	
2000	0.86	-1.18	-0.95	-0.11		
2100						
2200	1.26					
2300	0.99					
2400	0.86					$\Sigma P = 7.42\ g\,m^{-2}\,day^{-1}$
2500	0.72					
2600	0.73					$\bar{R} = 0.86\ g\,m^{-3}\,hr^{-1}$
2700	0.74					
2800	0.75					
2900						
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P =\ \ \ \ g\,m^{-2}\,day^{-1}$

**Daylight savings time.


Channel 8
Stations 2 - 10
Date: 8-23-77
Lag Time: 2.06 Hr.
Daylight
10
2
D.O. mg/ℓ
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
TIME IN HOURS

HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 2 to 10 in Channel 8

Date: 8-23-77 Travel Time: 2.06 Hrs

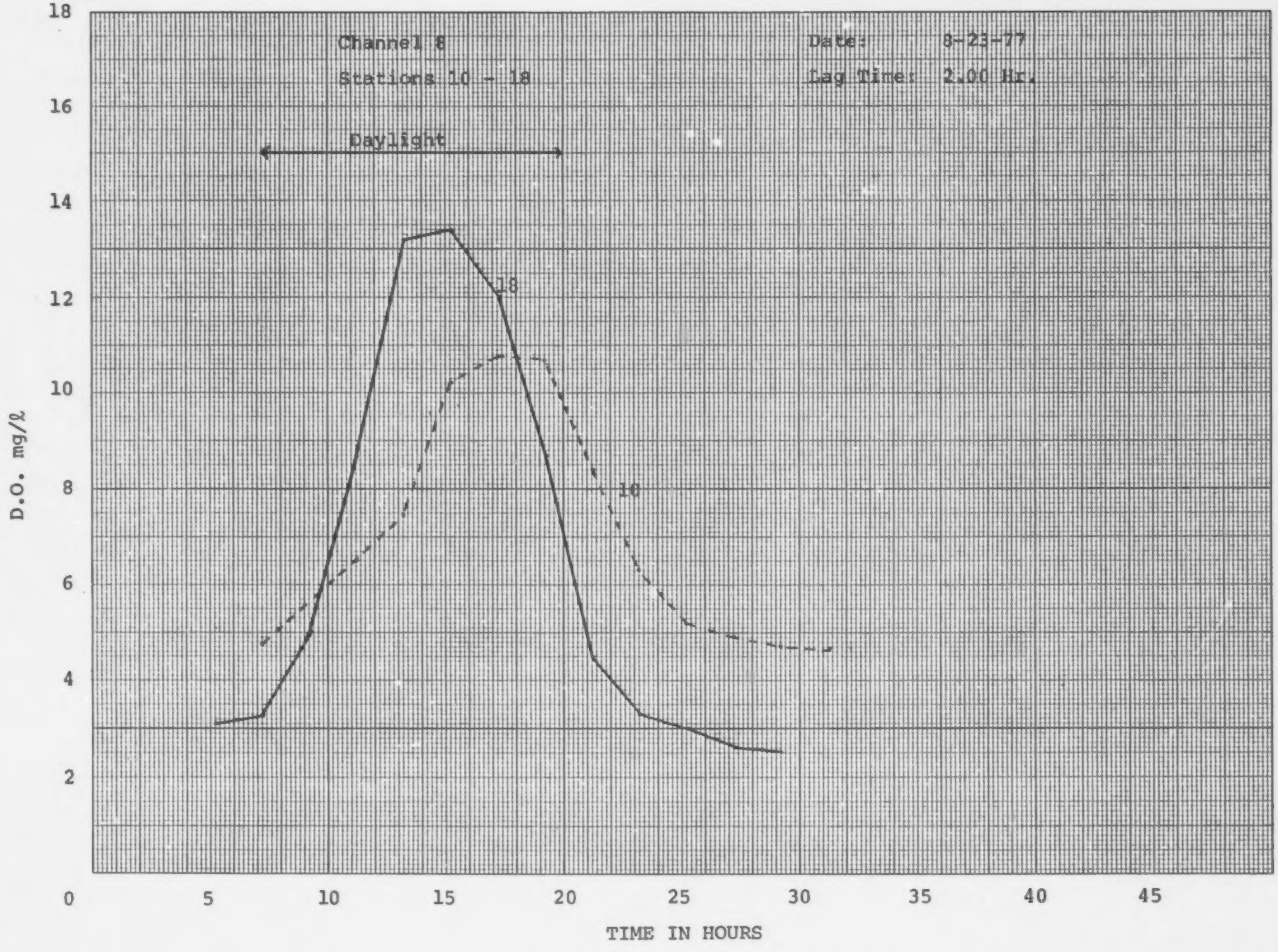
Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800	1.39	-1.28	-0.62	0.77	0.31	
0900		-0.41	-0.20	1.19	0.48	
1000		-0.02	-0.01	1.38	0.55	
1100		0.30	0.15	1.54	0.62	
1200		1.03	0.50	1.89	0.76	
1300		1.98	0.96	2.35	0.94	
1400		2.09	1.01	2.40	0.96	
1500		1.98	0.96	2.35	0.94	
1600		1.54	0.75	2.14	0.86	
1700		1.05	0.51	1.90	0.76	
1800		-0.05	-0.02	1.37	0.55	
1900		-1.27	-0.62	0.77	0.31	
2000	1.39	-2.18	-1.06	0.33	0.13	
2100						
2200	1.59					
2300	1.67					
2400	1.53					
2500	1.37					
2600	1.31					
2700	1.21					
2800	1.21					
2900	1.21					
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						

$P = 8.17\ g\ m^{-2}\ day^{-1}$

$\bar{R} = 1.39\ g\ m^{-3}\ hr^{-1}$

$P = \quad g\ m^{-2}\ day^{-1}$

**Daylight savings time.


Channel 8
Stations 10 - 18
Date: 8-23-77
Lag Time: 2.00 Hr.
Daylight
18
10
D.O. mg/ℓ
TIME IN HOURS
0
2
4
6
8
10
12
14
16
18
5
10
15
20
25
30
35
40
45

HOURLY RESPIRATION & PHOTOSYNTHETIC RATES FROM D.O. DIFFERENTIAL

LOCATION OF REACH: Station 10 to 18 in Channel 8

Date: 8-23-77 Travel Time: 2.00 Hrs.

Time at Downstream Station (hrs)	R $g\ m^{-3}\ hr^{-1}$	ΔD.O. $g\ m^{-3}$	ΔD.O. $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-3}\ hr^{-1}$	P $g\ m^{-2}\ hr^{-1}$	Comments
0000 **						D.O. values below 3 mg/ℓ not used in calculating R-value
0100						
0200						
0300						
0400						
0500						
0600 ↑						
0700						
0800	1.59	-1.17	-0.59	1.00	0.38	
0900	↓	-0.78	-0.39	1.20	0.46	
1000		0.39	0.20	1.79	0.68	
1100		1.80	0.90	2.49	0.95	
1200		3.50	1.75	3.34	1.27	
1300		4.77	2.39	3.98	1.51	
1400		4.79	2.40	3.99	1.52	
1500		3.50	1.75	3.34	1.27	
1600		2.46	1.23	2.82	1.07	
1700		1.52	0.76	2.35	0.89	
1800		0.16	0.08	1.67	0.63	
1900 ↓	↓	-1.52	-0.76	0.83	0.32	
2000	1.59	-2.62	-1.31	0.28	0.11	
2100						
2200	1.81					
2300						
2400	1.43					$\Sigma P = 11.06\ g\ m^{-2}\ day^{-1}$
2500	1.54					$\bar{R} = 1.59\ g\ m^{-3}\ hr^{-1}$
2600						
2700						
2800						
2900						
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						$\Sigma P\quad = g\ m^{-2}\ day^{-1}$

**Daylight savings time.

APPENDIX C

HYDRAULIC MEAN DEPTHS FOR 1976-77
DIEL D.O. CURVE ANALYSIS

HYDRAULIC MEAN DEPTHS FOR 1976-77 DIEL D.O. CURVE ANALYSIS (METERS)

Date / Station Nos.		Channel Nos. 1	4	5	8
7-28-76					
6	10	0.53 a	0.53 a	0.53 a	0.53 a
14	18	0.49 a	0.49 a	0.49 a	0.49 a
8-5-76					
6	10	0.53 a	0.53 a	0.53 a	0.53 a
14	18	0.49 a	0.49 a	0.49 a	0.49 a
10-27-76					
2	10			0.34 b	0.34 b
10	18			0.36 b	0.36 b
1-26-77					
2	10			0.34 b	0.34 b
10	18			0.36 b	0.36 b
4-25-77					
2	10			0.34 b	0.34 b
10	18			0.36 b	0.36 b
7-19-77					
2	10	0.40 c		0.38 c	0.40 c
10	18	0.38 c		0.37 c	0.38 c
8-23-77					
2	10			0.38 c	0.40 c
10	18			0.37 c	0.38 c

a - Determined from 10-4-76 and 10-18-76 morphological survey in Channel 1.
b - Determined from 4-6-77 morphological survey in Channel 1.
c - Determined from 8-4-77 and 8-5-77 morphological survey in Channels 5 and 8.

APPENDIX D

COEFFICIENT DERIVATION FOR
ADJUSTMENT OF PARTIAL DAILY
RATES OF PHOTOSYNTHESIS TO
TOTAL DAILY RATES OF PHOTOSYNTHESIS

(EXAMPLE)

HOURLY PHOTOSYNTHETIC RATES ($gm^{-2}\ hr^{-1}$) FROM D.O. DIFFERENTIAL ON APRIL 25, 1977.

Time at Downstream Station (hrs.)	Channel 5 Station 2 to 10	Channel 5 Station 10 to 18	Channel 8 Station 2 to 10	Channel 8 Station 10 to 18
0000				
0100				
0200				
0300				
0400				
0500				
0600				
0700	0.18	0.23	0.29	0.40
0800	0.31	0.37	0.59	0.75
0900	0.37	0.46	0.77	0.86
1000	0.42	0.53	0.94	0.94
1100	0.46	0.57	1.03	0.95
1200	0.49	0.60	1.11	0.95
1300	0.48	0.56	1.09	0.88
1400	0.46	0.54	1.06	0.74
1500	0.42	0.48	0.93	0.65
1600	0.38	0.40	1.01	0.53
1700	0.29	0.29	0.52	0.36
1800	0.20	0.15	0.48	0.16
1900	0.09	0.03	0.27	0.01
2000				
2100				
2200				
2300				
2400				
$\frac{\Sigma\ P(total)}{\Sigma\ P(10\ hours)}$	$\frac{4.55}{3.97}$	$\frac{5.21}{4.74}$	$\frac{10.09}{8.82}$	$\frac{8.18}{7.65}$
	=	=	=	=
	1.15	1.10	1.14	1.07

$$\text{Mean Coefficient Value} = \frac{4.46}{4} = 1.12$$

The 4-26-77 data set contained only 10 of the 13 daylight hours. The coefficient was derived by dividing the total daily photosynthetic rates for each segment by the sum of the first 10 hourly photosynthetic rates. The four coefficients were averaged to determine a mean coefficient value that represents the fraction by which the 4-26-77 photosynthetic rates were initially underestimated.

APPENDIX E

DORM INPUT DATA AND

SIMULATION PRINTOUTS FOR 8 RUNS

(INPUT DATA FORMAT FOLLOWS SPECIFICATIONS IN

APPENDIX B OF GULLIVER ET AL, 1980)

DORM INPUT DATA FOR APRIL 25 and 26, 1977

IN CHANNEL 5 FROM STATION 2 TO 10

```
    115.      0.01      720.      25.0      000.      0.46      36.5      2.00
    4.00      45.0      93.0      90.0      0.001     1.00      0.00      1.045
    0.00      544.      744.
  5.44E-4   3.80E-5   1.49E00
   8   19   18   20    2    2    3    0
 17.7 3.39 17.7 3.99 18.4 4.00 17.2 3.31 15.4
 10.7 6.60 10.7 6.20 11.2 6.70 11.3 6.40 10.9
  91.  88.  84.  74.  67.  67.  67.  51.  35.
 100. 100. 100. 100. 100. 100. 100. 100. 100.
  5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4
CHANNEL 5  APRIL 25  1977

 9.25  9.08  8.91  8.74  8.58  8.41  8.24  8.07  7.90
 14.8
 13.5                              12.6
 13.2                              12.5
 13.3                              12.4
 14.1                              13.4
 14.8                              15.0
 15.1                              16.1
 15.0                              16.4
 14.5                              15.6
 14.4                              14.4
 14.5                              13.6
 14.3                              13.3
 14.3                              13.2
 14.0                              13.4
 13.6                              13.2
 13.8                              13.2
 14.4                              14.2
 15.4                              15.6
 16.0                              17.0
 16.2                              17.6
 2.0  2.7  2.5  3.2  3.8  5.2  5.6  4.5  3.0  2.0  1.8  2.4
 3.0  3.4  3.8  5.6  5.8  4.5  3.7                          17.0
332. 333. 346. 349. 351. 324. 324. 320. 352. 197. 178. 198.
185. 162. 178. 182. 219. 252. 279.
9.25 9.10 9.5010.1010.8511.3011.5011.7010.5010.15 9.90 9.65
9.30 9.00 9.5010.2010.6010.9011.00
4.03 6.03 8.0310.0312.0314.0316.0318.0320.0322.0324.0326.03
28.0330.0332.0334.0336.0338.0340.03
8.00 9.3010.4011.4011.9011.8010.90 9.10 8.70 8.30 8.30 7.90
7.70 9.2010.6011.3011.7011.55
6.12 8.1210.1212.1214.1216.1218.1220.1222.1224.1226.1228.12
30.1232.1234.1236.1238.1240.12
```

DORM SIMULATION PRINTOUT FOR APRIL 25 AND 26, 1977

IN CHANNEL 5 FROM STATIONS 2 TO 10

CHANNEL 5

ESTIMATION OF CHANNEL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES

BY NUMERICALLY ROUTING DIEL DISSOLVED OXYGEN MEASUREMENTS

BETWEEN TWO STATIONS

STARTING DATE = APRIL 25 1977

LIST OF SYMBOLS:

C = D.O.CONCENTRATION G/M**3)
DSTAR = DIMENSIONLESS LONGITUDINAL DISPERSION NUMBER
EPS = COEFFICIENT WHICH SPECIFIES TIME STEP METHOD
(1.0 FOR FULLY IMPLICIT, 0.5 FOR CRANK-NICOLSON IMPLICIT)
P = PHOTOSYNTHETIC RATE OF CHANNEL REACH (G/(M*M*HR))
T = WATER TEMPERATURE (DEG. C)
TR = HYDRAULIC RESIDENCE TIME OF CHANNEL REACH (HR)

INPUT DATA

COMPUTATIONAL TIME INCREMENT = 720 SEC
COMPUTATIONAL DISTANCE INCREMENT = 7.6 M
EPS = 1.00
DSTAR = .01
MAXIMUM ERROR IN R OR P FOR ITERATION CONVERGENCE = .0010 G/(M*M*HR)
MAXIMUM ITERATIONS = 20
CONSTANT FOR ARRHENIUS RELATION = 1.045
CONSTANT REPRESENTATING RESPIRATION INHIBITION DUE TO LOW D. O. CONC. = 0 G/M**3
ORDER OF EQUATION FIT TO UPSTREAM D. O. MEASUREMENTS = 3

INPUT DATA FOR EACH SEGMENT

SEGMENT NUMBER	2	3	4	5	6	7	8	9	10
INITIAL D.O. AT UPSTREAM END OF SEGMENT (G/M**3)	9.25	9.08	8.91	8.74	8.58	8.41	8.24	8.07	7.90
SEGMENT LENGTH (M)	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
CROSS-SECT. AREA (M*M)	1.64	.31	1.64	.37	1.71	.37	1.60	.31	
SURFACE WIDTH (M)	3.26	2.01	3.26	1.89	3.41	2.04	3.44	1.95	

SEGMENT DIRECTION (DEG)	91.	88.	84.	74.	67.	67.	67.	51.
WATER SURFACE SLOPE	.00051	.00051	.00051	.00051	.00051	.00051	.00051	.00051

WEATHER DATA INPUT TO MODEL

TIME	WIND VELOCITY (M/SEC)	WIND DIRECTION (DEGREES)	AIR PRESSURE (MB)
5.00	2.00	332.00	991.67
7.00	2.70	333.00	991.67
9.00	2.50	346.00	991.67
11.00	3.20	349.00	991.67
13.00	3.80	351.00	991.67
15.00	5.20	324.00	991.67
17.00	5.60	324.00	991.67
19.00	4.50	320.00	991.67
21.00	3.00	352.00	991.67
23.00	2.00	197.00	991.67
1.00	1.80	178.00	991.67
3.00	2.40	198.00	991.67
5.00	3.00	185.00	991.67
7.00	3.40	162.00	991.67
9.00	3.80	178.00	991.67
11.00	5.60	182.00	991.67
13.00	5.80	219.00	991.67
15.00	4.50	252.00	991.67
17.00	3.70	279.00	991.67

MEASURED DISSOLVED OXYGEN (G/M**3)

UPSTREAM TIME	UPSTREAM D.O.	DOWNSTREAM TIME	DOWNSTREAM D.O.
3.05	9.25	5.20	8.00
5.05	9.10	7.20	9.30
7.05	9.50	9.20	10.40
9.05	10.10	11.20	11.40
11.05	10.85	13.20	11.90
13.05	11.30	15.20	11.80
15.05	11.50	17.20	10.90
17.05	11.20	19.20	9.10
19.05	10.50	21.20	8.70
21.05	10.15	23.20	8.30
23.05	9.90	25.20	8.30
25.05	9.65	27.20	7.90
27.05	9.30	29.20	7.70
29.05	9.00	31.20	9.20
31.05	9.50	33.20	10.60
33.05	10.20	35.20	11.30
35.05	10.60	37.20	11.70
37.05	10.90	39.20	11.55
39.05	11.00	0	I

```
STANDARD RESPIRATION RATE =    .4600 G/(M*M*HR) AT 20 DEG C    MEAN ERROR =   .0183     5 ITERATIONS
STANDARD RESPIRATION RATE =    .4417 G/(M*M*HR) AT 20 DEG C    MEAN ERROR =   .0003     8 ITERATIONS

********************************************************

RESULTS OF COMPUTATIONS:

STANDARD RESPIRATORY RATE =  .4417 G/(M*M*HR) AT 20 DEG C
SUNRISE TIME =  5.07
SUNSET TIME = 18.86
 8 ITERATIONS

ROUTED TOTAL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES
```

TIME	P	R	RESIDUAL	TR
	----G/(M*M*HR)----		G/M**3	HR
5.20	.067	.327	-.000	1.974
7.20	.356	.323	.000	1.974
9.20	.495	.329	-.000	1.974
11.20	.601	.345	-.000	1.974
13.20	.588	.359	-.000	1.974
15.20	.496	.365	.000	1.974
17.20	.278	.360	.000	1.974
19.20	0	.348	-.207	1.974
21.20	0	.340	.015	1.974
23.20	0	.338	-.083	1.974
1.20	0	.336	.125	1.974
3.20	0	.336	-.052	1.974
5.20	.009	.334	-.000	1.974
7.20	.367	.331	.000	1.974
9.20	.551	.338	-.000	1.974
11.20	.581	.353	-.000	1.974
13.20	.626	.371	-.000	1.974
15.20	.533	.372	.000	1.974

```
DAY  1
TOTAL DAILY RESPIRATION =  8.2098G/M**2
TOTAL DAILY PHOTOSYNTHESIS =  5.7736G/M**2
P/R RATIO =  .7033

DAY  2
TOTAL DAILY RESPIRATION =  8.6549G/M**2
TOTAL DAILY PHOTOSYNTHESIS =  5.3338G/M**2
P/R RATIO =  .6163
```

COMPUTED VALUES OF SURFACE D. O. EXCHANGE (G/(M*M*HR)),
SURFACE EXCHANGE COEFFICIENT (/HR),
SATURATION D.O. CONCENTRATION (G/M**3),
AND WATER TEMPERATURE (DEG. C)
FOR EACH CHANNEL SEGMENT

SECTION NO.	2	3	4	5	6	7	8	9
TIME = 5.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	.0310	.0121	.0460	.0212	.0402	.0249	.0497	.0241
SE COEFFICIENT	.0772	.0771	.0770	.0769	.0768	.0767	.0767	.0766
SAT. D.O. CONC.	9.90	9.96	10.02	10.08	10.15	10.21	10.27	10.34
TEMPERATURE	14.66	14.39	14.11	13.84	13.56	13.29	13.01	12.74
TIME = 7.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	.0374	.0132	.0460	.0195	.0532	.0209	.0569	.0208
SE COEFFICIENT	.0774	.0771	.0769	.0767	.0767	.0766	.0766	.0766
SAT. D.O. CONC.	10.17	10.20	10.23	10.26	10.29	10.32	10.35	10.38
TEMPERATURE	13.44	13.31	13.19	13.06	12.94	12.81	12.69	12.56
TIME = 9.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	.0204	.0063	.0210	.0082	.0217	.0081	.0218	.0078
SE COEFFICIENT	.0767	.0767	.0767	.0766	.0766	.0766	.0766	.0768
SAT. D.O. CONC.	10.24	10.27	10.29	10.31	10.34	10.36	10.39	10.41
TEMPERATURE	13.15	13.05	12.95	12.85	12.75	12.65	12.55	12.45
TIME = 11.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	-.0075	-.0034	-.0126	-.0060	-.0168	-.0071	-.0193	-.0075
SE COEFFICIENT	.0768	.0767	.0767	.0767	.0768	.0768	.0768	.0780
SAT. D.O. CONC.	10.21	10.20	10.20	10.20	10.19	10.19	10.19	10.19
TEMPERATURE	13.31	13.32	13.33	13.34	13.36	13.37	13.38	13.39
TIME = 13.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	-.0397	-.0140	-.0481	-.0204	-.0549	-.0215	-.0574	-.0217
SE COEFFICIENT	.0770	.0770	.0770	.0770	.0771	.0772	.0772	.0804
SAT. D.O. CONC.	10.01	9.98	9.96	9.93	9.91	9.88	9.86	9.83
TEMPERATURE	14.16	14.27	14.38	14.49	14.61	14.72	14.83	14.94
TIME = 15.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	-.0739	-.0239	-.0771	-.0288	-.0741	-.0284	-.0749	-.0266
SE COEFFICIENT	.0947	.0916	.0877	.0798	.0776	.0776	.0777	.0774
SAT. D.O. CONC.	9.85	9.81	9.78	9.74	9.71	9.67	9.64	9.60
TEMPERATURE	14.88	15.04	15.21	15.37	15.53	15.69	15.86	16.02
TIME = 17.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	-.0789	-.0242	-.0753	-.0266	-.0664	-.0246	-.0641	-.0222
SE COEFFICIENT	.0981	.0947	.0902	.0807	.0778	.0779	.0779	.0774
SAT. D.O. CONC.	9.78	9.75	9.71	9.68	9.64	9.61	9.58	9.54
TEMPERATURE	15.18	15.34	15.51	15.67	15.83	15.99	16.16	16.32

TIME = 19.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0498	-.0135	-.0388	-.0124	-.0283	-.0090	-.0213	-.0063
SE COEFFICIENT	.0922	.0898	.0864	.0801	.0778	.0779	.0779	.0772
SAT. D.O. CONC.	9.81	9.80	9.78	9.77	9.75	9.73	9.72	9.70
TEMPERATURE	15.04	15.11	15.19	15.26	15.34	15.41	15.49	15.56

TIME = 21.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0146	-.0018	-.0001	.0029	.0126	.0072	.0227	.0100
SE COEFFICIENT	.0770	.0770	.0770	.0770	.0770	.0770	.0770	.0784
SAT. D.O. CONC.	9.93	9.94	9.94	9.94	9.95	9.95	9.95	9.95
TEMPERATURE	14.49	14.48	14.47	14.46	14.44	14.43	14.42	14.41

TIME = 23.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0002	.0031	.0172	.0102	.0329	.0152	.0449	.0183
SE COEFFICIENT	.0770	.0770	.0770	.0772	.0775	.0775	.0774	.0788
SAT. D.O. CONC.	9.97	9.99	10.01	10.03	10.06	10.08	10.10	10.13
TEMPERATURE	14.35	14.25	14.15	14.05	13.95	13.85	13.75	13.65

TIME = 1.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0087	.0060	.0268	.0141	.0432	.0192	.0555	.0219
SE COEFFICIENT	.0770	.0770	.0769	.0769	.0769	.0768	.0768	.0770
SAT. D.O. CONC.	9.95	9.98	10.02	10.05	10.09	10.12	10.15	10.19
TEMPERATURE	14.43	14.27	14.12	13.97	13.82	13.68	13.53	13.38

TIME = 3.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0215	.0097	.0384	.0185	.0547	.0232	.0657	.0262
SE COEFFICIENT	.0770	.0770	.0770	.0776	.0784	.0784	.0784	.0813
SAT. D.O. CONC.	9.99	10.02	10.06	10.09	10.12	10.15	10.18	10.21
TEMPERATURE	14.23	14.09	13.96	13.82	13.68	13.54	13.41	13.27

TIME = 5.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0343	.0135	.0499	.0226	.0642	.0263	.0728	.0289
SE COEFFICIENT	.0769	.0769	.0769	.0771	.0778	.0778	.0777	.0819
SAT. D.O. CONC.	9.99	10.02	10.04	10.07	10.09	10.12	10.14	10.17
TEMPERATURE	14.24	14.13	14.02	13.91	13.79	13.68	13.57	13.46

TIME = 7.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0349	.0125	.0444	.0191	.0525	.0209	.0573	.0213
SE COEFFICIENT	.0772	.0770	.0769	.0768	.0768	.0768	.0767	.0772
SAT. D.O. CONC.	10.06	10.08	10.10	10.13	10.15	10.17	10.20	10.22
TEMPERATURE	13.95	13.85	13.75	13.65	13.55	13.45	13.35	13.25

TIME = 9.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0149	.0044	.0144	.0054	.0145	.0053	.0145	.0056
SE COEFFICIENT	.0768	.0768	.0768	.0769	.0776	.0776	.0775	.0840
SAT. D.O. CONC.	10.14	10.15	10.17	10.18	10.19	10.20	10.21	10.22
TEMPERATURE	13.57	13.52	13.47	13.42	13.38	13.32	13.27	13.22

TIME = 11.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0108	-.0048	-.0184	-.0089	-.0268	-.0111	-.0302	-.0137
SE COEFFICIENT	.0769	.0769	.0769	.0792	.0848	.0848	.0848	.1026
SAT. D.O. CONC.	10.09	10.07	10.06	10.05	10.04	10.03	10.02	10.01
TEMPERATURE	13.82	13.87	13.92	13.97	14.03	14.07	14.12	14.18

TIME = 13.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0417	-.0163	-.0611	-.0294	-.0852	-.0341	-.0923	-.0365
SE COEFFICIENT	.1010	.1045	.1090	.1194	.1255	.1254	.1254	.1349
SAT. D.O. CONC.	9.94	9.91	9.87	9.84	9.81	9.77	9.74	9.71
TEMPERATURE	14.47	14.62	14.77	14.93	15.07	15.22	15.37	15.53

TIME = 15.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0703	-.0249	-.0870	-.0372	-.1002	-.0391	-.1045	-.0364
SE COEFFICIENT	.1112	.1123	.1134	.1149	.1146	.1145	.1145	.1100
SAT. D.O. CONC.	9.71	9.67	9.63	9.59	9.55	9.50	9.46	9.42
TEMPERATURE	15.50	15.70	15.90	16.10	16.30	16.50	16.70	16.90

TIME = 17.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0682	-.0205	-.0656	-.0247	-.0613	-.0225	-.0587	-.0187
SE COEFFICIENT	.1021	.1015	.1007	.0974	.0944	.0944	.0943	.0860
SAT. D.O. CONC.	9.59	9.55	9.50	9.46	9.42	9.38	9.34	9.30
TEMPERATURE	16.10	16.30	16.50	16.70	16.90	17.10	17.30	17.50

DORM INPUT DATA FOR APRIL 25 and 26, 1977

IN CHANNEL 5 FROM STATION 10 TO 18

```
      115.       0.01       720.       25.0       800.       0.40       36.5       2.00
      4.00       45.0       93.0       90.0       0.001      1.00       0.00       1.045
      0.00       544.       744.
   5.44E-4    3.80E-5    1.49E00
    8   19   18   20   10    2    3    0
  17.4 3.63 19.0 3.35 19.2 3.59 18.1 2.60 18.1
  10.9 5.90 11.1 5.90 10.8 5.90 10.7 5.40 10.7
   35.  16.  81. 351. 351. 351. 351. 351. 351.
  100. 100. 100. 100. 100. 100. 100. 100. 100.
   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4
 CHANNEL 5  APRIL 25  1977


   7.90  7.74  7.58  7.41  7.25  7.09  6.93  6.76  6.60
  12.6                                        12.4
  12.5                                        12.2
  12.4                                        12.1
  13.4                                        13.4
  15.0                                        15.9
  16.1                                        17.8
  16.4                                        18.4
  15.6                                        17.4
  14.4                                        15.7
  13.6                                        14.5
  13.3                                        13.4
  13.2                                        13.1
  13.4                                        13.2
  13.2                                        13.1
  13.2                                        13.2
  14.2                                        14.7
  15.6                                        16.9
  17.0                                        18.8
  17.6                                        19.7
  17.0                                        19.0
   2.0  2.7  2.5  3.2  3.8  5.2  5.6  4.5  3.0  2.0  1.8  2.4
   3.0  3.4  3.8  5.6  5.8  4.5  3.7
  332. 333. 346. 349. 351. 324. 324. 320. 352. 197. 178. 198.
  185. 162. 178. 182. 219. 252. 279.
  7.90 8.00 9.3010.4011.4011.9011.8010.90 9.10 8.70 8.30 8.30
  7.90 7.70 9.2010.6011.3011.7011.55
  4.12 6.12 8.1210.1212.1214.1216.1218.1220.1222.1224.1226.12
 28.1230.1232.1234.1236.1238.1240.12
  6.80 8.5010.7012.0512.7012.3510.80 8.40 7.20 6.90 6.70 6.60
  6.50 8.4010.8012.2012.9014.45
  6.21 8.2110.2112.2114.2116.2118.2120.2122.2124.2126.2128.21
 30.2132.2134.2136.2138.2140.21
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DORM SIMULATION PRINTOUT FOR APRIL 25 and 26, 1977

IN CHANNEL 5 FROM STATIONS 10 TO 18

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                              CHANNEL 5

  ESTIMATION OF CHANNEL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES

    BY NUMERICALLY ROUTING DIEL DISSOLVED OXYGEN MEASUREMENTS

                    BETWEEN TWO STATIONS

                    STARTING DATE = APRIL 25  1977

  LIST OF SYMBOLS:

  C = D.O.CONCENTRATION G/M**3)
  DSTAR = DIMENSIONLESS LONGITUDINAL DISPERSION NUMBER
  EPS = COEFFICIENT WHICH SPECIFIES TIME STEP METHOD
        (1.0 FOR FULLY IMPLICIT, 0.5 FOR CRANK-NICOLSON IMPLICIT)
  P = PHOTOSYNTHETIC RATE OF CHANNEL REACH (G/(M*M*HR))
  T = WATER TEMPERATURE (DEG. C)
  TR = HYDRAULIC RESIDENCE TIME OF CHANNEL REACH (HR)

  INPUT DATA

  COMPUTATIONAL TIME INCREMENT =  720. SEC
  COMPUTATIONAL DISTANCE INCREMENT =  7.6 M
  EPS = 1.00
  DSTAR =  .01
  MAXIMUM ERROR IN R OR P FOR ITERATION CONVERGENCE = .0010 G/(M*M*HR)
  MAXIMUM ITERATIONS = 20
  CONSTANT FOR ARRHENIUS RELATION = 1.045
  CONSTANT REPRESENTATING RESPIRATION INHIBITION DUE TO LOW D. O. CONC. =    0 G/M**3
  ORDER OF EQUATION FIT TO UPSTREAM D. O. MEASUREMENTS = 3

  INPUT DATA FOR EACH SEGMENT

        SEGMENT NUMBER    10    11    12    13    14    15    16    17    18
INITIAL D.O. AT UPSTREAM
```

END OF SEGMENT (G/M**3)	7.90	7.74	7.58	7.41	7.25	7.09	6.93	6.76	6.60
SEGMENT LENGTH (M)	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
CROSS-SECT. AREA (M*M)	1.62	.34	1.77	.31	1.78	.33	1.68	.24	
SURFACE WIDTH (M)	3.32	1.80	3.38	1.80	3.29	1.80	3.26	1.65	
SEGMENT DIRECTION (DEG)	35.	16.	81.	351.	351.	351.	351.	351.	
WATER SURFACE SLOPE	.00051	.00051	.00051	.00051	.00051	.00051	.00051	.00051	

WEATHER DATA INPUT TO MODEL

TIME	WIND VELOCITY (M/SEC)	WIND DIRECTION (DEGREES)	AIR PRESSURE (MB)
5.00	2.00	332.00	991.67
7.00	2.70	333.00	991.67
9.00	2.50	346.00	991.67
11.00	3.20	349.00	991.67
13.00	3.80	351.00	991.67
15.00	5.20	324.00	991.67
17.00	5.60	324.00	991.67
19.00	4.50	320.00	991.67
21.00	3.00	352.00	991.67
23.00	2.00	197.00	991.67
1.00	1.80	178.00	991.67
3.00	2.40	198.00	991.67
5.00	3.00	185.00	991.67
7.00	3.40	162.00	991.67
9.00	3.80	178.00	991.67
11.00	5.60	182.00	991.67
13.00	5.80	219.00	991.67
15.00	4.50	252.00	991.67
17.00	3.70	279.00	991.67

MEASURED DISSOLVED OXYGEN (G/M**3)

UPSTREAM TIME	UPSTREAM D.O.	DOWNSTREAM TIME	DOWNSTREAM D.O.
3.20	7.90	5.35	6.80
5.20	8.00	7.35	8.50
7.20	9.30	9.35	10.70
9.20	10.40	11.35	12.05
11.20	11.40	13.35	12.70
13.20	11.90	15.35	12.35
15.20	11.80	17.35	10.80
17.20	10.90	19.35	8.40
19.20	9.10	21.35	7.20
21.20	8.70	23.35	6.90
23.20	8.30	25.35	6.70
25.20	8.30	27.35	6.60
27.20	7.90	29.35	6.50
29.20	7.70	31.35	8.40
31.20	9.20	33.35	10.80
33.20	10.60	35.35	12.20
35.20	11.30	37.35	12.90
37.20	11.70	39.35	14.45
39.20	11.55	0	I

STANDARD RESPIRATION RATE = .4000 G/(M*M*HR) AT 20 DEG C   MEAN ERROR = -.1272   5 ITERATIONS

STANDARD RESPIRATION RATE = .5272 G/(M*M*HR) AT 20 DEG C   MEAN ERROR = -.0028   8 ITERATIONS

STANDARD RESPIRATION RATE = .5299 G/(M*M*HR) AT 20 DEG C   MEAN ERROR = -.0001   10 ITERATIONS

RESULTS OF COMPUTATIONS:

STANDARD RESPIRATORY RATE = .5299 G/(M*M*HR) AT 20 DEG C
SUNRISE TIME = 5.07
SUNSET TIME = 18.86
10 ITERATIONS

ROUTED TOTAL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES

TIME	P	R	RESIDUAL	TR
	----G/(M*M*HR)	----	G/M**3	HR
5.35	.091	.379	.000	1.999
7.35	.426	.379	-.000	1.999
9.35	.680	.397	.000	1.999
11.35	.786	.431	.000	1.999
13.35	.791	.460	.000	1.999
15.35	.642	.470	.000	1.999
17.35	.309	.455	.000	1.999
19.35	0	.429	-.236	1.999
21.35	0	.410	-.094	1.999
23.35	0	.397	.017	1.999
1.35	0	.393	.052	1.999
3.35	0	.394	.019	1.999
5.35	.044	.392	.000	1.999
7.35	.473	.395	-.000	1.999
9.35	.741	.415	.000	1.999
11.35	.825	.448	.000	1.999
13.35	.878	.480	-.000	1.999
15.35	1.117	.468	-.000	1.999

DAY 1
TOTAL DAILY RESPIRATION = 9.9805G/M**2
TOTAL DAILY PHOTOSYNTHESIS = 7.4819G/M**2
P/R RATIO = .7497

DAY 2
TOTAL DAILY RESPIRATION = 10.8060G/M**2
TOTAL DAILY PHOTOSYNTHESIS = 8.1561G/M**2
P/R RATIO = .7548

COMPUTED VALUES OF SURFACE D. O. EXCHANGE (G/(M*M*HR)),
SURFACE EXCHANGE COEFFICIENT (/HR),
SATURATION D.O. CONCENTRATION (G/M**3),
AND WATER TEMPERATURE (DEG. C)
FOR EACH CHANNEL SEGMENT

TIME = 5.00 FLOW RATE = .0343 (M**3/SEC)

SECTION NO.	10	11	12	13	14	15	16	17
SURFACE EXCH.	.0921	.0381	.1024	.0403	.1309	.0467	.1341	.0397
SE COEFFICIENT	.0740	.0749	.0739	.0774	.0774	.0774	.0774	.0774
SAT. D.O. CONC.	10.38	10.38	10.39	10.39	10.40	10.41	10.41	10.42
TEMPERATURE	12.59	12.56	12.54	12.51	12.49	12.46	12.44	12.41

TIME = 7.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0737	.0320	.0893	.0357	.1166	.0419	.1210	.0360
SE COEFFICIENT	.0744	.0780	.0739	.0843	.0843	.0843	.0843	.0843
SAT. D.O. CONC.	10.40	10.41	10.42	10.43	10.44	10.45	10.46	10.47
TEMPERATURE	12.48	12.44	12.41	12.37	12.33	12.29	12.26	12.22

TIME = 9.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0316	.0131	.0355	.0135	.0451	.0162	.0487	.0146
SE COEFFICIENT	.0758	.0798	.0738	.0833	.0833	.0834	.0834	.0834
SAT. D.O. CONC.	10.43	10.44	10.44	10.45	10.46	10.47	10.48	10.49
TEMPERATURE	12.38	12.34	12.31	12.27	12.23	12.19	12.16	12.12

TIME = 11.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0213	-.0107	-.0269	-.0127	-.0407	-.0149	-.0410	-.0123
SE COEFFICIENT	.0803	.0876	.0741	.0923	.0923	.0923	.0923	.0923
SAT. D.O. CONC.	10.18	10.18	10.18	10.18	10.18	10.18	10.18	10.18
TEMPERATURE	13.40	13.40	13.40	13.40	13.40	13.40	13.40	13.40

TIME = 13.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0737	-.0345	-.0788	-.0379	-.1224	-.0441	-.1255	-.0375
SE COEFFICIENT	.0859	.0953	.0745	.1003	.1003	.1003	.1003	.1002
SAT. D.O. CONC.	9.81	9.79	9.76	9.74	9.71	9.69	9.67	9.64
TEMPERATURE	15.06	15.17	15.28	15.39	15.51	15.62	15.73	15.84

TIME = 15.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0872	-.0433	-.1126	-.0543	-.1746	-.0622	-.1773	-.0525
SE COEFFICIENT	.0765	.0917	.0818	.1123	.1122	.1121	.1120	.1120
SAT. D.O. CONC.	9.57	9.52	9.48	9.43	9.39	9.35	9.31	9.27
TEMPERATURE	16.21	16.42	16.63	16.84	17.06	17.27	17.48	17.69

TIME = 17.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0769	-.0382	-.0971	-.0466	-.1491	-.0523	-.1490	-.0435
SE COEFFICIENT	.0772	.0949	.0837	.1176	.1175	.1174	.1173	.1172
SAT. D.O. CONC.	9.50	9.45	9.40	9.35	9.30	9.25	9.20	9.15
TEMPERATURE	16.52	16.77	17.02	17.27	17.52	17.77	18.02	18.27

TIME = 19.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0229	-.0098	-.0281	-.0112	-.0368	-.0124	-.0366	-.0102
SE COEFFICIENT	.0749	.0833	.0813	.1009	.1009	.1008	.1007	.1007
SAT. D.O. CONC.	9.67	9.62	9.57	9.53	9.48	9.44	9.39	9.35
TEMPERATURE	15.71	15.94	16.16	16.39	16.61	16.84	17.06	17.29

TIME = 21.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0350	.0166	.0417	.0185	.0587	.0214	.0597	.0181
SE COEFFICIENT	.0800	.0861	.0744	.0894	.0894	.0893	.0893	.0893
SAT. D.O. CONC.	9.94	9.90	9.87	9.83	9.79	9.76	9.72	9.69
TEMPERATURE	14.48	14.64	14.81	14.97	15.13	15.29	15.46	15.62

TIME = 23.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0626	.0272	.0767	.0289	.0944	.0345	.0992	.0300
SE COEFFICIENT	.0775	.0783	.0742	.0769	.0769	.0769	.0769	.0769
SAT. D.O. CONC.	10.12	10.10	10.07	10.05	10.02	10.00	9.97	9.95
TEMPERATURE	13.66	13.77	13.88	13.99	14.11	14.22	14.33	14.44

TIME = 1.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0715	.0313	.0908	.0343	.1135	.0419	.1219	.0371
SE COEFFICIENT	.0750	.0763	.0740	.0767	.0767	.0767	.0767	.0767
SAT. D.O. CONC.	10.21	10.20	10.20	10.20	10.19	10.19	10.19	10.19
TEMPERATURE	13.31	13.32	13.33	13.34	13.36	13.37	13.38	13.39

TIME = 3.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0855	.0370	.0992	.0384	.1268	.0466	.1356	.0412
SE COEFFICIENT	.0811	.0822	.0743	.0795	.0795	.0795	.0795	.0795
SAT. D.O. CONC.	10.23	10.23	10.24	10.24	10.24	10.25	10.25	10.25
TEMPERATURE	13.19	13.18	13.17	13.16	13.14	13.13	13.12	13.11

TIME = 7.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0737	.0320	.0893	.0357	.1166	.0419	.1210	.0360
SE COEFFICIENT	.0744	.0780	.0739	.0843	.0843	.0843	.0843	.0843
SAT. D.O. CONC.	10.40	10.41	10.42	10.43	10.44	10.45	10.46	10.47
TEMPERATURE	12.48	12.44	12.41	12.37	12.33	12.29	12.26	12.22

TIME = 9.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0316	.0131	.0355	.0135	.0451	.0162	.0487	.0146
SE COEFFICIENT	.0758	.0798	.0738	.0833	.0833	.0834	.0834	.0834
SAT. D.O. CONC.	10.43	10.44	10.44	10.45	10.46	10.47	10.48	10.49
TEMPERATURE	12.38	12.34	12.31	12.27	12.23	12.19	12.16	12.12

TIME = 11.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0213	-.0107	-.0269	-.0127	-.0407	-.0149	-.0410	-.0123
SE COEFFICIENT	.0803	.0876	.0741	.0923	.0923	.0923	.0923	.0923
SAT. D.O. CONC.	10.18	10.18	10.18	10.18	10.18	10.18	10.18	10.18
TEMPERATURE	13.40	13.40	13.40	13.40	13.40	13.40	13.40	13.40

TIME = 13.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0737	-.0345	-.0788	-.0379	-.1224	-.0441	-.1255	-.0375
SE COEFFICIENT	.0859	.0953	.0745	.1003	.1003	.1003	.1003	.1002
SAT. D.O. CONC.	9.81	9.79	9.76	9.74	9.71	9.69	9.67	9.64
TEMPERATURE	15.06	15.17	15.28	15.39	15.51	15.62	15.73	15.84

TIME = 15.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0872	-.0433	-.1126	-.0543	-.1746	-.0622	-.1773	-.0525
SE COEFFICIENT	.0765	.0917	.0818	.1123	.1122	.1121	.1120	.1120
SAT. D.O. CONC.	9.57	9.52	9.48	9.43	9.39	9.35	9.31	9.27
TEMPERATURE	16.21	16.42	16.63	16.84	17.06	17.27	17.48	17.69

TIME = 17.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0769	-.0382	-.0971	-.0466	-.1491	-.0523	-.1490	-.0435
SE COEFFICIENT	.0772	.0949	.0837	.1176	.1175	.1174	.1173	.1172
SAT. D.O. CONC.	9.50	9.45	9.40	9.35	9.30	9.25	9.20	9.15
TEMPERATURE	16.52	16.77	17.02	17.27	17.52	17.77	18.02	18.27

TIME = 19.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0229	-.0098	-.0281	-.0112	-.0368	-.0124	-.0366	-.0102
SE COEFFICIENT	.0749	.0833	.0813	.1009	.1009	.1008	.1007	.1007
SAT. D.O. CONC.	9.67	9.62	9.57	9.53	9.48	9.44	9.39	9.35
TEMPERATURE	15.71	15.94	16.16	16.39	16.61	16.84	17.06	17.29

TIME = 21.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0350	.0166	.0417	.0185	.0587	.0214	.0597	.0181
SE COEFFICIENT	.0800	.0861	.0744	.0894	.0894	.0893	.0893	.0893
SAT. D.O. CONC.	9.94	9.90	9.87	9.83	9.79	9.76	9.72	9.69
TEMPERATURE	14.48	14.64	14.81	14.97	15.13	15.29	15.46	15.62

TIME = 23.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0626	.0272	.0767	.0289	.0944	.0345	.0992	.0300
SE COEFFICIENT	.0775	.0783	.0742	.0769	.0769	.0769	.0769	.0769
SAT. D.O. CONC.	10.12	10.10	10.07	10.05	10.02	10.00	9.97	9.95
TEMPERATURE	13.66	13.77	13.88	13.99	14.11	14.22	14.33	14.44

TIME = 1.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0715	.0313	.0908	.0343	.1135	.0419	.1219	.0371
SE COEFFICIENT	.0750	.0763	.0740	.0767	.0767	.0767	.0767	.0767
SAT. D.O. CONC.	10.21	10.20	10.20	10.20	10.19	10.19	10.19	10.19
TEMPERATURE	13.31	13.32	13.33	13.34	13.36	13.37	13.38	13.39

TIME = 3.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0855	.0370	.0992	.0384	.1268	.0466	.1356	.0412
SE COEFFICIENT	.0811	.0822	.0743	.0795	.0795	.0795	.0795	.0795
SAT. D.O. CONC.	10.23	10.23	10.24	10.24	10.24	10.25	10.25	10.25
TEMPERATURE	13.19	13.18	13.17	13.16	13.14	13.13	13.12	13.11

TIME = 5.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.1001	.0439	.1068	.0453	.1474	.0534	.1542	.0465
SE COEFFICIENT	.0845	.0889	.0741	.0885	.0885	.0885	.0885	.0885
SAT. D.O. CONC.	10.19	10.19	10.20	10.20	10.21	10.22	10.22	10.23
TEMPERATURE	13.39	13.36	13.34	13.31	13.29	13.26	13.24	13.21

TIME = 7.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0788	.0361	.0897	.0402	.1305	.0468	.1349	.0402
SE COEFFICIENT	.0787	.0873	.0740	.0946	.0946	.0946	.0946	.0946
SAT. D.O. CONC.	10.23	10.23	10.24	10.24	10.24	10.25	10.25	10.25
TEMPERATURE	13.19	13.18	13.17	13.16	13.14	13.13	13.12	13.11

TIME = 9.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0293	.0125	.0282	.0129	.0437	.0157	.0478	.0143
SE COEFFICIENT	.0901	.0982	.0740	.1005	.1005	.1005	.1005	.1005
SAT. D.O. CONC.	10.23	10.23	10.23	10.23	10.23	10.23	10.23	10.23
TEMPERATURE	13.20	13.20	13.20	13.20	13.20	13.20	13.20	13.20

TIME = 11.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	-.0450	-.0225	-.0398	-.0253	-.0809	-.0293	-.0810	-.0241
SE COEFFICIENT	.1141	.1260	.0745	.1270	.1270	.1270	.1269	.1269
SAT. D.O. CONC.	9.99	9.98	9.97	9.95	9.94	9.92	9.91	9.90
TEMPERATURE	14.23	14.29	14.36	14.42	14.48	14.54	14.61	14.67
TIME = 13.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	-.1156	-.0471	-.1220	-.0418	-.1368	-.0499	-.1432	-.0430
SE COEFFICIENT	.1313	.1238	.1076	.1012	.1012	.1011	.1011	.1011
SAT. D.O. CONC.	9.68	9.64	9.61	9.57	9.54	9.51	9.47	9.44
TEMPERATURE	15.68	15.84	16.01	16.17	16.33	16.49	16.66	16.82
TIME = 15.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	-.1125	-.0428	-.1706	-.0433	-.1445	-.0535	-.1555	-.0471
SE COEFFICIENT	.0971	.0834	.1092	.0750	.0751	.0751	.0752	.0752
SAT. D.O. CONC.	9.38	9.34	9.29	9.25	9.20	9.16	9.12	9.07
TEMPERATURE	17.11	17.34	17.56	17.79	18.01	18.24	18.46	18.69
TIME = 17.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	-.0705	-.0321	-.1221	-.0346	-.1158	-.0430	-.1278	-.0393
SE COEFFICIENT	.0765	.0751	.0958	.0754	.0755	.0755	.0756	.0757
SAT. D.O. CONC.	9.26	9.21	9.16	9.11	9.06	9.01	8.96	8.91
TEMPERATURE	17.73	17.99	18.26	18.52	18.78	19.04	19.31	19.57

DORM INPUT DATA FOR APRIL 25 and 26, 1977

IN CHANNEL 8 FROM STATIONS 2 TO 10

```
      115.       0.01       720.       25.0       800.       0.70       36.5       2.00
      4.00       45.0       93.0       70.0       0.001      1.00       0.00       1.045
      0.00       544.       744.
    5.44E-4    3.80E-5    1.49E00
    8   19   18   20    2    2    3    0
 17.7 3.39 17.7 3.99 18.4 4.00 17.2 3.31 15.4
 10.7 6.60 10.7 6.20 11.2 6.70 11.3 6.40 10.9
   91.   88.   84.   74.   67.   67.   67.   51.   35.
 100. 100. 100. 100. 100. 100. 100. 100. 100.
   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4
CHANNEL 8  APRIL 25  1977


  8.10  7.72  7.34  6.96  6.58  6.20  5.81  5.43  5.05
 19.6                                    17.2
 19.2                                    17.4
 18.8                                    17.1
 18.9                                    18.1
 19.5                                    19.5
 20.3                                    20.5
 20.5                                    20.8
 20.6                                    20.2
 20.2                                    20.0
 20.0                                    18.4
 19.9                                    18.0
 20.0                                    17.8
 19.9                                    17.9
 19.6                                    17.8
 19.2                                    17.8
 19.4                                    19.1
 20.0                                    20.0
 20.8                                    21.4
 21.9                                    22.0
 21.8                                    21.6
  2.0  2.7  2.5  3.2  3.8  5.2  5.6  4.5  3.0  2.0  1.8  2.4
  3.0  3.4  3.8  5.6  5.8  4.5  3.7
 332. 333. 346. 349. 351. 324. 324. 320. 252. 197. 178. 198.
 185. 162. 178. 182. 219. 252. 279.
 8.10 7.70 8.20 8.70 9.20 9.85 9.95 9.50 9.10 8.75 8.40 7.70
 7.90 7.75 7.90 8.70 9.10 9.25 9.25
 4.03 6.03 8.0310.0312.0314.0316.0318.0320.0322.0324.0326.03
28.0330.0332.0334.0336.0338.0340.03
 4.80 7.9010.4011.8012.0511.30 9.05 6.02 5.45 5.10 4.95 4.70
 4.40 7.9010.6011.8012.0011.20
 6.12 8.1210.1212.1214.1216.1218.1220.1222.1224.1226.1228.12
30.1232.1234.1236.1238.1240.12
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DORM SIMULATION PRINTOUT FOR APRIL 25 and 26, 1977

IN CHANNEL 8 FROM STATIONS 2 TO 10

CHANNEL 8

ESTIMATION OF CHANNEL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES

BY NUMERICALLY ROUTING DIEL DISSOLVED OXYGEN MEASUREMENTS

BETWEEN TWO STATIONS

STARTING DATE = APRIL 25 1977

LIST OF SYMBOLS:

C = D.O.CONCENTRATION G/M**3)
DSTAR = DIMENSIONLESS LONGITUDINAL DISPERSION NUMBER
EPS = COEFFICIENT WHICH SPECIFIES TIME STEP METHOD
(1.0 FOR FULLY IMPLICIT, 0.5 FOR CRANK-NICOLSON IMPLICIT)
P = PHOTOSYNTHETIC RATE OF CHANNEL REACH (G/(M*M*HR))
T = WATER TEMPERATURE (DEG. C)
TR = HYDRAULIC RESIDENCE TIME OF CHANNEL REACH (HR)

INPUT DATA

COMPUTATIONAL TIME INCREMENT = 720. SEC
COMPUTATIONAL DISTANCE INCREMENT = 7.6 M
EPS = 1.00
DSTAR = .01
MAXIMUM ERROR IN R OR P FOR ITERATION CONVERGENCE = .0010 G/(M*M*HR)
MAXIMUM ITERATIONS = 20
CONSTANT FOR ARRHENIUS RELATION = 1.045
CONSTANT REPRESENTATING RESPIRATION INHIBITION DUE TO LOW D. O. CONC. = 0 G/M**3
ORDER OF EQUATION FIT TO UPSTREAM D. O. MEASUREMENTS = 3

INPUT DATA FOR EACH SEGMENT

SEGMENT NUMBER	2	3	4	5	6	7	8	9	10
INITIAL D.O. AT UPSTREAM END OF SEGMENT (G/M**3)	8.10	7.72	7.34	6.96	6.58	6.20	5.81	5.43	5.05
SEGMENT LENGTH (M)	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
CROSS-SECT. AREA (M*M)	1.64	.31	1.64	.37	1.71	.37	1.60	.31	
SURFACE WIDTH (M)	3.26	2.01	3.26	1.89	3.41	2.04	3.44	1.95	
SEGMENT DIRECTION (DEG)	91.	88.	84.	74.	67.	67.	67.	51.	
WATER SURFACE SLOPE	.00051	.00051	.00051	.00051	.00051	.00051	.00051	.00051	

WEATHER DATA INPUT TO MODEL

TIME	WIND VELOCITY (M/SEC)	WIND DIRECTION (DEGREES)	AIR PRESSURE (MB)
5.00	2.00	332.00	991.67
7.00	2.70	333.00	991.67
9.00	2.50	346.00	991.67
11.00	3.20	349.00	991.67
13.00	3.80	351.00	991.67
15.00	5.20	324.00	991.67
17.00	5.60	324.00	991.67
19.00	4.50	320.00	991.67
21.00	3.00	252.00	991.67
23.00	2.00	197.00	991.67
1.00	1.80	170.00	991.67
3.00	2.40	198.00	991.67
5.00	3.00	185.00	991.67
7.00	3.40	162.00	991.67
9.00	3.80	178.00	991.67
11.00	5.60	182.00	991.67
13.00	5.80	219.00	991.67
15.00	4.50	257.00	991.67
17.00	3.70	279.00	991.67

MEASURED DISSOLVED OXYGEN (G/M**3)

UPSTREAM TIME	UPSTREAM D.O.	DOWNSTREAM TIME	DOWNSTREAM D.O.
3.05	8.10	5.20	4.80
5.05	7.70	7.20	7.90
7.05	8.20	9.20	10.40
9.05	8.70	11.20	11.80
11.05	9.20	13.20	12.05
13.05	9.85	15.20	11.30
15.05	9.95	17.20	9.05
17.05	9.50	19.20	6.02
19.05	9.10	21.20	5.45
21.05	8.75	23.20	5.10
23.05	8.40	25.20	4.95
25.05	7.70	27.20	4.70
27.05	7.90	29.20	4.40
29.05	7.75	31.20	7.90
31.05	7.90	33.20	10.60
33.05	8.70	35.20	11.80
35.05	9.10	37.20	12.00
37.05	9.25	39.20	11.20
39.05	9.25	0	I

STANDARD RESPIRATION RATE = .7000 G/(M*M*HR) AT 20 DEG C MEAN ERROR = -.0089 6 ITERATIONS

STANDARD RESPIRATION RATE = .7089 G/(M*M*HR) AT 20 DEG C MEAN ERROR = -.0002 9 ITERATIONS

****

RESULTS OF COMPUTATIONS:

STANDARD RESPIRATORY RATE = .7089 G/(M*M*HR) AT 20 DEG C
SUNRISE TIME = 5.07

SUNSET TIME = 18.86
9 ITERATIONS

ROUTED TOTAL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES

TIME	P	R	RESIDUAL	TR
	----G/(M*M*HR)----		G/M**3	HR
5.20	0	.657	-.029	1.974
7.20	.717	.650	.000	1.974
9.20	1.106	.662	-.000	1.974
11.20	1.298	.689	.000	1.974
13.20	1.264	.716	-.000	1.974
15.20	1.017	.728	.000	1.974
17.20	.539	.722	-.000	1.974
19.20	0	.712	-.007	1.974
21.20	0	.689	-.080	1.974
23.20	0	.678	-.170	1.974
1.20	0	.675	.018	1.974
3.20	0	.674	.226	1.974
5.20	0	.670	-.134	1.974
7.20	.739	.665	.000	1.974
9.20	1.214	.682	-.000	1.974
11.20	1.323	.706	.000	1.974
13.20	1.332	.738	.000	1.974
15.20	1.102	.740	-.000	1.974

DAY 1
TOTAL DAILY RESPIRATION = 16.5019G/M**2
TOTAL DAILY PHOTOSYNTHESIS = 11.8798G/M**2
P/R RATIO = .7199

DAY 2

TOTAL DAILY RESPIRATION = 17.2770G/M**2
TOTAL DAILY PHOTOSYNTHESIS = 11.4209G/M**2
P/R RATIO = .6610

COMPUTED VALUES OF SURFACE D. O. EXCHANGE (G/(M*M*HR)),
SURFACE EXCHANGE COEFFICIENT (/HR),
SATURATION D.O. CONCENTRATION (G/M**3),
AND WATER TEMPERATURE (DEG. C)
FOR EACH CHANNEL SEGMENT

SECTION NO.	2	3	4	5	6	7	8	9
TIME = 5.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	.0472	.0196	.0772	.0368	.1070	.0444	.1251	.0472
SE COEFFICIENT	.0783	.0781	.0780	.0779	.0779	.0778	.0777	.0777
SAT. D.O. CONC.	8.93	8.99	9.04	9.10	9.16	9.21	9.27	9.33
TEMPERATURE	19.45	19.15	18.85	18.55	18.25	17.95	17.65	17.35
TIME = 7.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	.0470	.0181	.0663	.0225	.0829	.0338	.0943	.0355
SE COEFFICIENT	.0785	.0783	.0781	.0779	.0778	.0778	.0777	.0777
SAT. D.O. CONC.	9.00	9.04	9.08	9.13	9.17	9.21	9.26	9.30
TEMPERATURE	19.09	18.86	18.64	18.41	18.19	17.96	17.74	17.51
TIME = 9.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	.0258	.0068	.0199	.0065	.0153	.0049	.0136	.0048
SE COEFFICIENT	.0780	.0779	.0779	.0778	.0778	.0777	.0777	.0778
SAT. D.O. CONC.	9.07	9.11	9.15	9.19	9.24	9.28	9.32	9.36
TEMPERATURE	18.69	18.48	18.27	18.06	17.84	17.63	17.42	17.21
TIME = 11.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	.0015	-.0036	-.0203	-.0124	-.0396	-.0184	-.0530	-.0213
SE COEFFICIENT	.0780	.0780	.0780	.0779	.0779	.0779	.0779	.0788
SAT. D.O. CONC.	9.04	9.06	9.08	9.10	9.12	9.14	9.16	9.18
TEMPERATURE	18.85	18.75	18.65	18.55	18.45	18.35	18.25	18.15
TIME = 13.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	-.0260	-.0127	-.0509	-.0249	-.0732	-.0316	-.0895	-.0358
SE COEFFICIENT	.0782	.0782	.0782	.0782	.0782	.0782	.0782	.0809
SAT. D.O. CONC.	8.92	8.92	8.92	8.92	8.92	8.92	8.92	8.92
TEMPERATURE	19.50	19.50	19.50	19.50	19.50	19.50	19.50	19.50
TIME = 15.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	-.0563	-.0209	-.0725	-.0297	-.0812	-.0333	-.0923	-.0347
SE COEFFICIENT	.0938	.0909	.0873	.0804	.0787	.0787	.0787	.0784
SAT. D.O. CONC.	8.78	8.77	8.77	8.76	8.76	8.75	8.75	8.74
TEMPERATURE	20.31	20.34	20.36	20.39	20.41	20.44	20.46	20.49

TIME = 17.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0513	-.0162	-.0516	-.0189	-.0489	-.0189	-.0513	-.0188
SE COEFFICIENT	.0970	.0938	.0896	.0812	.0788	.0788	.0788	.0785
SAT. D.O. CONC.	8.74	8.73	8.73	8.72	8.71	8.71	8.70	8.69
TEMPERATURE	20.52	20.56	20.59	20.63	20.67	20.71	20.74	20.78

TIME = 19.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0239	-.0027	.0014	.0049	.0198	.0106	.0317	.0128
SE COEFFICIENT	.0914	.0892	.0863	.0807	.0789	.0788	.0788	.0783
SAT. D.O. CONC.	8.73	8.74	8.75	8.76	8.76	8.77	8.78	8.79
TEMPERATURE	20.57	20.52	20.47	20.42	20.37	20.33	20.28	20.23

TIME = 21.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0007	.0076	.0413	.0244	.0775	.0355	.1029	.0396
SE COEFFICIENT	.0899	.0905	.0912	.0920	.0919	.0919	.0919	.0896
SAT. D.O. CONC.	8.80	8.80	8.81	8.81	8.82	8.82	8.82	8.83
TEMPERATURE	20.19	20.16	20.14	20.11	20.09	20.06	20.04	20.01

TIME = 23.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0160	.0116	.0525	.0278	.0856	.0381	.1103	.0440
SE COEFFICIENT	.0783	.0782	.0782	.0783	.0785	.0785	.0784	.0795
SAT. D.O. CONC.	8.85	8.89	8.92	8.96	9.00	9.03	9.07	9.11
TEMPERATURE	19.90	19.70	19.50	19.30	19.10	18.90	18.70	18.50

TIME = 1.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0365	.0177	.0710	.0345	.1015	.0435	.1233	.0476
SE COEFFICIENT	.0782	.0782	.0781	.0781	.0780	.0780	.0779	.0780
SAT. D.O. CONC.	8.87	8.91	8.96	9.00	9.05	9.09	9.14	9.18
TEMPERATURE	19.78	19.54	19.31	19.07	18.83	18.59	18.36	18.12

TIME = 3.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0483	.0210	.0858	.0409	.1198	.0504	.1414	.0554
SE COEFFICIENT	.0783	.0782	.0782	.0786	.0792	.0792	.0791	.0815
SAT. D.O. CONC.	8.86	8.91	8.96	9.01	9.06	9.11	9.16	9.22
TEMPERATURE	19.86	19.59	19.31	19.04	18.76	18.49	18.21	17.94

TIME = 5.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0495	.0224	.0886	.0423	.1241	.0523	.1471	.0584
SE COEFFICIENT	.0782	.0782	.0781	.0782	.0787	.0787	.0786	.0821
SAT. D.O. CONC.	8.87	8.92	8.96	9.01	9.06	9.10	9.15	9.20
TEMPERATURE	19.77	19.52	19.27	19.02	18.77	18.52	18.27	18.02

TIME = 7.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0475	.0180	.0450	.0293	.0020	.0341	.0261	.0368

SE COEFFICIENT	.0784	.0782	.0781	.0780	.0779	.0779	.0778	.0782
SAT. D.O. CONC.	8.92	8.97	9.01	9.05	9.09	9.14	9.18	9.22
TEMPERATURE	19.49	19.26	19.04	18.81	18.59	18.36	18.14	17.91

TIME = 9.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0281	.0069	.0186	.0053	.0109	.0027	.0069	.0022
SE COEFFICIENT	.0781	.0780	.0780	.0780	.0785	.0785	.0785	.0839
SAT. D.O. CONC.	8.99	9.03	9.06	9.09	9.13	9.16	9.19	9.23
TEMPERATURE	19.11	18.94	18.76	18.59	18.41	18.24	18.06	17.89

TIME = 11.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0007	-.0048	-.0254	-.0152	-.0508	-.0233	-.0672	-.0318
SE COEFFICIENT	.0781	.0781	.0781	.0799	.0847	.0847	.0847	.1014
SAT. D.O. CONC.	8.94	8.95	8.96	8.96	8.97	8.98	8.99	8.99
TEMPERATURE	19.38	19.34	19.31	19.27	19.23	19.19	19.16	19.12

TIME = 13.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0244	-.0149	-.0666	-.0372	-.1169	-.0510	-.1452	-.0606
SE COEFFICIENT	.0997	.1031	.1075	.1175	.1234	.1234	.1234	.1327
SAT. D.O. CONC.	8.83	8.83	8.83	8.83	8.83	8.83	8.83	8.83
TEMPERATURE	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00

TIME = 15.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0384	-.0183	-.0737	-.0360	-.1055	-.0451	-.1282	-.0477
SE COEFFICIENT	.1096	.1106	.1118	.1132	.1130	.1130	.1129	.1087
SAT. D.O. CONC.	8.68	8.67	8.66	8.64	8.63	8.62	8.60	8.59
TEMPERATURE	20.84	20.91	20.99	21.06	21.14	21.21	21.29	21.36

TIME = 17.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.0311	-.0084	-.0275	-.0108	-.0282	-.0113	-.0330	-.0120
SE COEFFICIENT	.1007	.1003	.0995	.0965	.0936	.0936	.0936	.0859
SAT. D.O. CONC.	8.52	8.51	8.51	8.50	8.50	8.49	8.49	8.49
TEMPERATURE	21.81	21.84	21.86	21.89	21.91	21.94	21.96	21.99

DORM INPUT DATA FOR APRIL 25 and 26, 1977

IN CHANNEL 8 FROM STATIONS 10 TO 18

```
      115.       0.01       720.       25.0       800.       0.40       36.5       2.00
      4.00       45.0       93.0       90.0      0.001       1.00       0.00      1.045
      0.00       544.       744.
   5.44E-4    3.80E-5    1.47E00
    8   19   18   20   10    2    3    0
  17.4 3.63 19.0 3.35 19.2 3.59 18.1 2.40 18.1
  10.9 5.90 11.1 5.90 10.8 5.90 10.7 5.40 10.7
   35.  16.  81. 351. 351. 351. 351. 351. 351.
  100. 100. 100. 100. 100. 100. 100. 100. 100.
   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4   5.08E-4
 CHANNEL 8  APRIL 25  1977


   5.05  4.86  4.68  4.49  4.30  4.11  3.93  3.74  3.55
  17.2                                      16.3
  17.4                                      16.2
  17.1                                      16.1
  18.1                                      16.6
  19.5                                      17.7
  20.5                                      18.9
  20.8                                      19.7
  20.2                                      19.6
  20.0                                      19.2
  18.4                                      18.4
  18.0                                      17.6
  17.8                                      17.3
  17.9                                      17.1
  17.8                                      17.0
  17.8                                      16.9
  19.1                                      17.7
  20.0                                      20.2
  21.4                                      22.1
  22.0                                      23.0
  21.6                                      22.5
   2.0  2.7  2.5  3.2  3.8  5.2  5.6  4.5  3.0  2.0  1.8  2.4
   3.0  3.4  3.8  5.6  5.8  4.5  3.7
  332  333  346  349  351  324  324  320  352  197  178  198
  185. 162. 178. 182. 219. 252. 279.
  5.05 4.80 7.9010.4011.8012.0511.30 9.05 6.20 5.45 5.10 4.95
  4.70 4.40 7.9010.6011.8012.0011.20
  4.12 6.12 8.1210.1212.1214.1216.1218.1220.1222.1224.1226.12
 28.1230.1232.1234.1236.1238.1240.12
  3.90 7.5011.6014.0014.1013.0010.00 5.90 3.80 3.40 3.30 3.10
  3.70 7.4011.8014.0014.2012.90
  6.21 8.2110.2112.2114.2116.2118.2120.2122.2124.2126.2128.21
 30.2132.2134.2136.2138.2140.21
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DORM SIMULATION PRINTOUT FOR APRIL 25 and 26, 1977

IN CHANNEL 8 FROM STATIONS 10 TO 18

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CHANNEL 8

ESTIMATION OF CHANNEL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES
BY NUMERICALLY ROUTING DIEL DISSOLVED OXYGEN MEASUREMENTS
BETWEEN TWO STATIONS
STARTING DATE = APRIL 25 1977

LIST OF SYMBOLS:

C = D.O.CONCENTRATION G/M**3)
DSTAR = DIMENSIONLESS LONGITUDINAL DISPERSION NUMBER
EPS = COEFFICIENT WHICH SPECIFIES TIME STEP METHOD
      (1.0 FOR FULLY IMPLICIT, 0.5 FOR CRANK-NICOLSON IMPLICIT)
P = PHOTOSYNTHETIC RATE OF CHANNEL REACH (G/(M*M*HR))
T = WATER TEMPERATURE (DEG. C)
TR = HYDRAULIC RESIDENCE TIME OF CHANNEL REACH (HR)

INPUT DATA

COMPUTATIONAL TIME INCREMENT =  720. SEC
COMPUTATIONAL DISTANCE INCREMENT =  7.6 M
EPS = 1.00
DSTAR =  .01
MAXIMUM ERROR IN R OR P FOR ITERATION CONVERGENCE = .0010 G/(M*M*HR)
MAXIMUM ITERATIONS = 20
CONSTANT FOR ARRHENIUS RELATION = 1.045
CONSTANT REPRESENTATING RESPIRATION INHIBITION DUE TO LOW D. O. CONC. =     0 G/M**3
ORDER OF EQUATION FIT TO UPSTREAM D. O. MEASUREMENTS = 3

INPUT DATA FOR EACH SEGMENT
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SEGMENT NUMBER	10	11	12	13	14	15	16	17	18
INITIAL D.O. AT UPSTREAM END OF SEGMENT (G/M**3)	5.05	4.86	4.68	4.49	4.30	4.11	3.93	3.74	3.55
SEGMENT LENGTH (M)	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
CROSS-SECT. AREA (M*M)	1.62	.34	1.77	.31	1.78	.33	1.68	.24	
SURFACE WIDTH (M)	3.32	1.80	3.38	1.80	3.29	1.80	3.26	1.65	
SEGMENT DIRECTION (DEG)	35.	16.	81.	351.	351.	351.	351.	351.	
WATER SURFACE SLOPE	.00051	.00051	.00051	.00051	.00051	.00051	.00051	.00051	

WEATHER DATA INPUT TO MODEL

TIME	WIND VELOCITY (M/SEC)	WIND DIRECTION (DEGREES)	AIR PRESSURE (MB)
5.00	2.00	332.00	991.67
7.00	2.70	333.00	991.67
9.00	2.50	346.00	991.67
11.00	3.20	349.00	991.67
13.00	3.80	351.00	991.67
15.00	5.20	324.00	991.67
17.00	5.60	324.00	991.67
19.00	4.50	320.00	991.67
21.00	3.00	352.00	991.67
23.00	2.00	197.00	991.67
1.00	1.80	178.00	991.67
3.00	2.40	198.00	991.67
5.00	3.00	185.00	991.67
7.00	3.40	162.00	991.67
9.00	3.80	178.00	991.67
11.00	5.60	182.00	991.67
13.00	5.80	219.00	991.67
15.00	4.50	252.00	991.67
17.00	3.70	275.00	991.67

MEASURED DISSOLVED OXYGEN (G/M**3)

UPSTREAM TIME	UPSTREAM D.O.	DOWNSTREAM TIME	DOWNSTREAM D.O.
3.20	5.05	5.35	3.90
5.20	4.80	7.35	7.50
7.20	7.90	9.35	11.60
9.20	10.40	11.35	14.00
11.20	11.80	13.35	14.10
13.20	12.05	15.35	13.00
15.20	11.30	17.35	10.00
17.20	9.05	19.35	5.90
19.20	6.20	21.35	3.80
21.20	5.45	23.35	3.40
23.20	5.10	25.35	3.30
25.20	4.95	27.35	3.10
27.20	4.70	29.35	3.70
29.20	4.40	31.35	7.40
31.20	7.90	33.35	11.80
33.20	10.60	35.35	14.00
35.20	11.80	37.35	14.20
37.20	12.00	39.35	12.90
39.20	11.20	0	I

STANDARD RESPIRATION RATE = .4000 G/(M*M*HR) AT 20 DEG C MEAN ERROR = -.1673 6 ITERATIONS

STANDARD RESPIRATION RATE = .5673 G/(M*M*HR) AT 20 DEG C MEAN ERROR = -.0044 10 ITERATIONS

STANDARD RESPIRATION RATE = .5716 G/(M*M*HR) AT 20 DEG C MEAN ERROR = -.0001 12 ITERATIONS

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RESULTS OF COMPUTATIONS:

STANDARD RESPIRATORY RATE = .5716 G/(M*M*HR) AT 20 DEG C
SUNRISE TIME = 5.07
SUNSET TIME = 18.86
12 ITERATIONS

ROUTED TOTAL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES

TIME	P	R	RESIDUAL	TR
	----G/(M*M*HR)	----	G/M**3	HR
5.35	.171	.494	.000	1.999
7.35	.933	.494	-.000	1.999
9.35	1.249	.509	.000	1.999
11.35	1.316	.535	.000	1.999
13.35	1.114	.561	.000	1.999
15.35	.869	.575	.000	1.999
17.35	.363	.569	.000	1.999
19.35	0	.560	-.442	1.999
21.35	0	.536	-.288	1.999
23.35	0	.520	.030	1.999
1.35	0	.514	.168	1.999
3.35	0	.512	.069	1.999
5.35	.203	.510	.000	1.999
7.35	.976	.511	-.000	1.999
9.35	1.333	.533	.000	1.999
11.35	1.352	.572	.000	1.999
13.35	1.204	.613	.000	1.999
15.35	.828	.591	-.000	1.999

DAY 1
TOTAL DAILY RESPIRATION = 12.7549G/M**2
TOTAL DAILY PHOTOSYNTHESIS = 12.0911G/M**2
P/R RATIO = .9480

DAY 2
TOTAL DAILY RESPIRATION = 13.7545G/M**2
TOTAL DAILY PHOTOSYNTHESIS = 11.7917G/M**2
P/R RATIO = .8573

COMPUTED VALUES OF SURFACE D. O. EXCHANGE (G/(M*M*HR)),
SURFACE EXCHANGE COEFFICIENT (/HR),
SATURATION D.O. CONCENTRATION (G/M**3),
AND WATER TEMPERATURE (DEG. C)
FOR EACH CHANNEL SEGMENT

SECTION NO.	10	11	12	13	14	15	16	17
TIME = 5.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	.1691	.0681	.1920	.0683	.2177	.0762	.2160	.0631
SE COEFFICIENT	.0750	.0757	.0748	.0777	.0777	.0777	.0777	.0777
SAT. D.O. CONC.	9.37	9.40	9.42	9.44	9.47	9.49	9.51	9.53
TEMPERATURE	17.14	17.03	16.92	16.81	16.69	16.58	16.47	16.36
TIME = 7.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	.1296	.0538	.1474	.0557	.1776	.0618	.1753	.0508
SE COEFFICIENT	.0754	.0783	.0749	.0839	.0839	.0839	.0839	.0839
SAT. D.O. CONC.	9.34	9.37	9.40	9.43	9.46	9.49	9.52	9.55
TEMPERATURE	17.32	17.17	17.02	16.88	16.73	16.58	16.43	16.28
TIME = 9.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	.0311	.0113	.0305	.0100	.0335	.0109	.0337	.0091
SE COEFFICIENT	.0764	.0798	.0748	.0830	.0830	.0830	.0831	.0831
SAT. D.O. CONC.	9.40	9.42	9.45	9.47	9.50	9.52	9.55	9.57
TEMPERATURE	17.04	16.91	16.79	16.66	16.54	16.41	16.29	16.16
TIME = 11.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	-.0651	-.0315	-.0802	-.0364	-.1169	-.0429	-.1203	-.0365
SE COEFFICIENT	.0803	.0871	.0750	.0916	.0916	.0916	.0917	.0917
SAT. D.O. CONC.	9.20	9.24	9.28	9.31	9.35	9.39	9.43	9.47
TEMPERATURE	18.01	17.82	17.63	17.44	17.26	17.07	16.88	16.69
TIME = 13.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	-.1257	-.0587	-.1370	-.0650	-.2104	-.0764	-.2189	-.0660
SE COEFFICIENT	.0855	.0945	.0753	.0995	.0996	.0996	.0997	.0997
SAT. D.O. CONC.	8.94	8.98	9.03	9.07	9.11	9.15	9.20	9.24
TEMPERATURE	19.39	19.16	18.94	18.71	18.49	18.26	18.04	17.81
TIME = 15.00 FLOW RATE = .0343 (M**3/SEC)								
SURFACE EXCH.	-.1193	-.0585	-.1531	-.0736	-.2382	-.0858	-.2467	-.0740
SE COEFFICIENT	.0771	.0910	.0817	.1113	.1113	.1114	.1115	.1115
SAT. D.O. CONC.	8.76	8.80	8.83	8.87	8.90	8.94	8.98	9.01
TEMPERATURE	20.40	20.20	20.00	19.80	19.60	19.40	19.20	19.00

TIME = 17.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0748	.0376	.0989	.0484	.1585	.0570	.1663	.0498
SE COEFFICIENT	.0777	.0942	.0835	.1165	.1165	.1166	.1166	.1167
SAT. D.O. CONC.	8.70	8.73	8.75	8.77	8.80	8.82	8.85	8.87
TEMPERATURE	20.73	20.59	20.46	20.32	20.18	20.04	19.91	19.77

TIME = 19.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0218	.0090	.0206	.0081	.0197	.0058	.0098	.0021
SE COEFFICIENT	.0758	.0831	.0813	.1000	.1000	.1001	.1001	.1001
SAT. D.O. CONC.	8.80	8.82	8.83	8.84	8.86	8.87	8.88	8.90
TEMPERATURE	20.16	20.09	20.01	19.94	19.86	19.79	19.71	19.64

TIME = 21.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.1075	.0470	.1173	.0479	.1496	.0523	.1436	.0417
SE COEFFICIENT	.0801	.0856	.0754	.0887	.0887	.0887	.0887	.0888
SAT. D.O. CONC.	8.84	8.86	8.88	8.89	8.91	8.93	8.95	8.97
TEMPERATURE	19.95	19.85	19.75	19.65	19.55	19.45	19.35	19.25

TIME = 23.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.1474	.0612	.1692	.0610	.1956	.0696	.1967	.0580
SE COEFFICIENT	.0779	.0786	.0752	.0773	.0773	.0773	.0773	.0773
SAT. D.O. CONC.	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13
TEMPERATURE	18.40	18.40	18.40	18.40	18.40	18.40	18.40	18.40

TIME = 1.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.1566	.0653	.1850	.0670	.2170	.0780	.2233	.0665
SE COEFFICIENT	.0759	.0768	.0750	.0772	.0772	.0772	.0772	.0772
SAT. D.O. CONC.	9.21	9.22	9.23	9.24	9.25	9.26	9.27	9.28
TEMPERATURE	17.98	17.92	17.87	17.82	17.77	17.73	17.68	17.63

TIME = 3.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.1744	.0733	.1945	.0723	.2340	.0840	.2405	.0716
SE COEFFICIENT	.0810	.0820	.0752	.0796	.0796	.0796	.0796	.0796
SAT. D.O. CONC.	9.25	9.26	9.27	9.29	9.30	9.31	9.32	9.34
TEMPERATURE	17.77	17.71	17.64	17.58	17.52	17.46	17.39	17.33

TIME = 5.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.1955	.0824	.1997	.0806	.2572	.0911	.2591	.0766
SE COEFFICIENT	.0841	.0883	.0750	.0879	.0879	.0879	.0879	.0879
SAT. D.O. CONC.	9.23	9.25	9.27	9.29	9.31	9.33	9.35	9.37
TEMPERATURE	17.85	17.75	17.65	17.55	17.45	17.35	17.25	17.15

TIME = 7.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.1394	.0607	.1498	.0632	.2011	.0699	.1983	.0574
SE COEFFICIENT	.0789	.0867	.0750	.0937	.0937	.0938	.0938	.0938
SAT. D.O. CONC.	9.25	9.27	9.29	9.31	9.33	9.35	9.37	9.39
TEMPERATURE	17.75	17.65	17.55	17.45	17.35	17.25	17.15	17.05

TIME = 9.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0285	.0105	.0240	.0091	.0312	.0099	.0313	.0081
SE COEFFICIENT	.0894	.0971	.0750	.0994	.0994	.0995	.0995	.0995
SAT. D.O. CONC.	9.26	9.28	9.30	9.32	9.34	9.37	9.39	9.41
TEMPERATURE	17.74	17.63	17.52	17.41	17.29	17.18	17.07	16.96

TIME = 11.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	-.1082	-.0525	-.0942	-.0575	-.1836	-.0668	-.1858	-.0557
SE COEFFICIENT	.1124	.1240	.0754	.1252	.1252	.1253	.1254	.1255
SAT. D.O. CONC.	9.01	9.05	9.08	9.11	9.14	9.18	9.21	9.25
TEMPERATURE	19.01	18.84	18.66	18.49	18.31	18.14	17.96	17.79

TIME = 13.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.1974	.0799	.2067	.0706	.2307	.0843	.2427	.0734
SE COEFFICIENT	.1292	.1221	.1064	.1002	.1002	.1002	.1002	.1002
SAT. D.O. CONC.	8.83	8.82	8.82	8.82	8.81	8.81	8.80	8.80
TEMPERATURE	20.01	20.04	20.06	20.09	20.11	20.14	20.16	20.19

TIME = 15.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.1529	.0552	.2098	.0523	.1715	.0624	.1815	.0548
SE COEFFICIENT	.0962	.0832	.1079	.0759	.0759	.0759	.0760	.0760
SAT. D.O. CONC.	8.58	8.56	8.55	8.53	8.52	8.50	8.49	8.47
TEMPERATURE	21.44	21.53	21.62	21.71	21.79	21.88	21.97	22.06

TIME = 17.00 FLOW RATE = .0343 (M**3/SEC)

SURFACE EXCH.	.0820	.0318	.1164	.0324	.1069	.0387	.1145	.0345
SE COEFFICIENT	.0771	.0760	.0950	.0763	.0763	.0763	.0763	.0764
SAT. D.O. CONC.	8.47	8.45	8.43	8.41	8.39	8.37	8.35	8.33
TEMPERATURE	22.06	22.19	22.31	22.44	22.56	22.69	22.81	22.94

DORM INPUT DATA FOR AUGUST 23, 1977

IN CHANNEL 5 FROM STATIONS 2 TO 10

```
      200.       0.01       720.        25.       800.       0.46      24.5       2.00
      5.00       45.0       93.0       90.0      0.001       1.00      00.0      1.045
      00.0       600.       744.
   5.44E-4     3.8E-5    1.49E0
    8   13   12   20    2    1    3    0
 23.0 5.20 21.8 3.80 17.2 4.10 19.8 3.80 23.0
 11.5  7.9 12.1  6.7 11.2  6.9 11.5  7.2 11.9
  91.  88.  84.  74.  67.  67.  67.  51.  35.
 100. 100. 100. 100. 100. 100. 100. 100. 100.
   5.67E-4   5.67E-4   5.67E-4   5.67E-4   5.67E-4   5.67E-4   5.67E-4   5.67E-4
CHANNEL 5 AUGUST 23 1977


  5.45  5.16  4.86  4.57  4.28  3.98  3.69  3.39  3.10
 19.9                                     19.2
 19.5                                     18.9
 19.3                                     19.0
 19.4                                     19.2
 20.2                                     20.7
 21.0                                     21.5
 21.7                                     21.8
 21.7                                     21.3
 21.2                                     20.7
 20.9                                     20.4
 20.6                                     20.0
 20.2                                     19.7
 19.7                                     19.3
 19.6                                     19.2
  2.5  2.5  2.0  3.0  3.5  3.7  3.0  2.7  2.0  1.7  1.5  1.5
  1.5
  40.  77. 360. 342. 361. 330. 361.  34.  34.  34. 375.  27.
  27.
 5.45 7.10 7.50 8.5511.0011.1311.3010.20 7.70 7.60 7.10 6.90
 5.90
 5.03 7.03 9.0311.0313.0315.0317.0319.0321.0323.0325.0327.03
29.03
 4.00 6.35 9.3013.5015.0014.2010.90 7.40 6.20 5.40 5.10 4.90
 7.12 9.1211.1213.1215.1217.1219.1221.1223.1225.1227.1229.12
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DORM SIMULATION PRINTOUT FOR AUGUST 23, 1977

IN CHANNEL 5 FROM STATIONS 2 TO 10

CHANNEL 5

ESTIMATION OF CHANNEL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES

BY NUMERICALLY ROUTING DIEL DISSOLVED OXYGEN MEASUREMENTS

BETWEEN TWO STATIONS

STARTING DATE =AUGUST 23 1977

LIST OF SYMBOLS:

C = D.O. CONCENTRATION G/M**3)
DSTAR = DIMENSIONLESS LONGITUDINAL DISPERSION NUMBER
EPS = COEFFICIENT WHICH SPECIFIES TIME STEP METHOD
(1.0 FOR FULLY IMPLICIT, 0.5 FOR CRANK-NICOLSON IMPLICIT)
P = PHOTOSYNTHETIC RATE OF CHANNEL REACH (G/(M*M*HR))
T = WATER TEMPERATURE (DEG. C)
TR = HYDRAULIC RESIDENCE TIME OF CHANNEL REACH (HR)

INPUT DATA

COMPUTATIONAL TIME INCREMENT = 720. SEC
COMPUTATIONAL DISTANCE INCREMENT = 7.6 M
EPS = 1.00
DSTAR = .01
MAXIMUM ERROR IN R OR P FOR ITERATION CONVERGENCE = .0010 G/(M*M*HR)
MAXIMUM ITERATIONS = 20
CONSTANT FOR ARRHENIUS RELATION = 1.045
CONSTANT REPRESENTATING RESPIRATION INHIBITION DUE TO LOW D. O. CONC. = 0 G/M**3
ORDER OF EQUATION FIT TO UPSTREAM D. O. MEASUREMENTS = 3

INPUT DATA FOR EACH SEGMENT

SEGMENT NUMBER	2	3	4	5	6	7	8	9	10
INITIAL D.O. AT UPSTREAM END OF SEGMENT (G/M**3)	5.45	5.16	4.86	4.57	4.28	3.98	3.69	3.39	3.10
SEGMENT LENGTH (M)	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
CROSS-SECT. AREA (M*M)	2.14	.48	2.03	.35	1.60	.38	1.84	.35	
SURFACE WIDTH (M)	3.51	2.41	3.69	2.04	3.41	2.10	3.51	2.19	
SEGMENT DIRECTION (DEG)	91.	88.	84.	74.	67.	67.	67.	51.	
WATER SURFACE SLOPE	.00057	.00057	.00057	.00057	.00057	.00057	.00057	.00057	

WEATHER DATA INPUT TO MODEL

TIME	WIND VELOCITY (M/SEC)	WIND DIRECTION (DEGREES)	AIR PRESSURE (MB)
6.00	2.50	40.00	991.67
8.00	2.50	77.00	991.67
10.00	2.00	360.00	991.67
12.00	3.00	342.00	991.67
14.00	[illegible]	[illegible]	991.67
16.00	3.70	330.00	991.67
18.00	3.00	361.00	991.67
20.00	2.70	34.00	991.67
22.00	2.00	34.00	991.67
24.00	1.70	34.00	991.67
2.00	1.50	325.00	991.67
4.00	1.50	27.00	991.67
6.00	1.50	27.00	991.67

MEASURED DISSOLVED OXYGEN (G/M**3)

UPSTREAM TIME	UPSTREAM D.O.	DOWNSTREAM TIME	DOWNSTREAM D.O.
4.05	5.45	6.20	4.00
6.05	7.10	8.20	6.35
8.05	7.50	10.20	9.30
10.05	8.55	12.20	13.50
12.05	11.00	14.20	15.00
14.05	11.13	16.20	14.20
16.05	11.30	18.20	10.90
18.05	10.20	20.20	7.40
20.05	7.70	22.20	6.20
22.05	7.60	24.20	5.40
24.05	7.10	26.20	5.10
26.05	6.90	28.20	4.90
28.05	5.90	0	I

STANDARD RESPIRATION RATE = .4600 G/(M*M*HR) AT 20 DEG C MEAN ERROR = .0264 6 ITERATIONS

STANDARD RESPIRATION RATE = .4336 G/(M*M*HR) AT 20 DEG C MEAN ERROR = .0007 9 ITERATIONS

```
*****************************************************

RESULTS OF COMPUTATIONS:

STANDARD RESPIRATORY RATE =  .4336 G/(M*M*HR) AT 20 DEG C
SUNRISE TIME =  4.61
SUNSET TIME = 19.58
 9 ITERATIONS

ROUTED TOTAL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES
```

TIME	P	R	RESIDUAL	TR
	----G/(M*M*HR)----		G/M**3	HR
6.20	0	.420	-.072	2.062
8.20	.266	.418	-.000	2.062
10.20	.785	.421	.000	2.062
12.20	1.456	.439	-.000	2.062
14.20	1.345	.456	.000	2.062
16.20	1.105	.466	.000	2.062
18.20	.400	.464	.000	2.062
20.20	0	.454	-.377	2.062
22.20	0	.447	.362	2.062
.20	0	.440	-.062	2.062
2.20	0	.433	-.093	2.062
4.20	0	.413	-.180	2.062

```
DAY  1
TOTAL DAILY RESPIRATION = 10.5420G/M**2
TOTAL DAILY PHOTOSYNTHESIS = 10.7151G/M**2
P/R RATIO = 1.0164

COMPUTED VALUES OF SURFACE D. O. EXCHANGE (G/(M*M*HR)),
                    SURFACE EXCHANGE COEFFICIENT (/HR),
                    SATURATION D.O. CONCENTRATION (G/M**3),
                    AND WATER TEMPERATURE (DEG. C)
                    FOR EACH CHANNEL SEGMENT
```

SECTION NO.	2	3	4	5	6	7	8	9
TIME = 6.00 FLOW RATE = .0378 (M**3/SEC)								
SURFACE EXCH.	.1367	.0508	.1548	.0554	.1634	.0679	.2082	.0694
SE COEFFICIENT	.0796	.0800	.0806	.0823	.0836	.0836	.0836	.0858
SAT. D.O. CONC.	8.86	8.87	8.89	8.91	8.92	8.94	8.95	8.97
TEMPERATURE	19.86	19.77	19.68	19.59	19.51	19.42	19.33	19.24

TIME = 8.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0966	.0375	.1158	.0412	.1207	.0511	.1589	.0516
SE COEFFICIENT	.0855	.0858	.0861	.0862	.0859	.0859	.0859	.0838
SAT. D.O. CONC.	8.93	8.94	8.96	8.97	8.98	9.00	9.01	9.03
TEMPERATURE	19.46	19.39	19.31	19.24	19.16	19.09	19.01	18.94

TIME = 10.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0517	.0171	.0474	.0149	.0412	.0163	.0507	.0168
SE COEFFICIENT	.0784	.0784	.0783	.0783	.0784	.0784	.0783	.0787
SAT.. D.O. CONC.	8.96	8.97	8.98	8.98	8.99	9.00	9.00	9.01
TEMPERATURE	19.28	19.24	19.21	19.17	19.13	19.09	19.06	19.02

TIME = 12.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.0306	-.0143	-.0463	-.0184	-.0558	-.0251	-.0765	-.0261
SE COEFFICIENT	.0785	.0784	.0784	.0784	.0784	.0784	.0783	.0785
SAT. D.O. CONC.	8.94	8.95	8.95	8.96	8.96	8.97	8.97	8.98
TEMPERATURE	19.39	19.36	19.34	19.31	19.29	19.26	19.24	19.21

TIME = 14.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.1109	-.0451	-.1393	-.0508	-.1503	-.0645	-.1966	-.0691
SE COEFFICIENT	.0786	.0786	.0786	.0788	.0793	.0793	.0793	.0838
SAT. D.O. CONC.	8.79	8.78	8.77	8.76	8.75	8.73	8.72	8.71
TEMPERATURE	20.23	20.29	20.36	20.42	20.48	20.54	20.61	20.67

TIME = 16.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.1382	-.0539	-.1631	-.0577	-.1685	-.0716	-.2206	-.0736
SE COEFFICIENT	.0814	.0805	.0797	.0789	.0788	.0788	.0789	.0789
SAT. D.O. CONC.	8.65	8.64	8.63	8.62	8.61	8.60	8.58	8.57
TEMPERATURE	21.03	21.09	21.16	21.22	21.28	21.34	21.41	21.47

TIME = 18.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.1177	-.0428	-.1252	-.0426	-.1219	-.0505	-.1553	-.0530
SE COEFFICIENT	.0789	.0789	.0789	.0790	.0792	.0792	.0792	.0815
SAT. D.O. CONC.	8.53	8.53	8.53	8.53	8.52	8.52	8.52	8.52
TEMPERATURE	21.71	21.72	21.73	21.74	21.76	21.77	21.78	21.79

TIME = 20.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.0354	-.0123	-.0364	-.0118	-.0335	-.0129	-.0410	-.0137
SE COEFFICIENT	.0797	.0800	.0806	.0825	.0840	.0840	.0840	.0871
SAT. D.O. CONC.	8.54	8.55	8.56	8.56	8.57	8.58	8.59	8.60
TEMPERATURE	21.68	21.62	21.58	21.52	21.48	21.43	21.38	21.32

TIME = 22.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0424	.0168	.0501	.0181	.0522	.0221	.0647	.0713
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SAT. D.O. CONC.	8.63	8.64	8.65	8.66	8.67	8.68	8.69	8.70
TEMPERATURE	21.17	21.11	21.04	20.98	20.92	20.86	20.79	20.73

TIME = 24.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0675	.0270	.0831	.0299	.0077	.0372	.1134	.0377
SE COEFFICIENT	.0788	.0788	.0789	.0791	.0794	.0794	.0793	.0799
SAT. D.O. CONC.	8.68	8.69	8.70	8.71	8.72	8.73	8.74	8.75
TEMPERATURE	20.87	20.81	20.74	20.68	20.62	20.56	20.49	20.43

TIME = 2.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0839	.0319	.0956	.0338	.0983	.0416	.1200	.0427
SE COEFFICIENT	.0787	.0786	.0786	.0786	.0787	.0787	.0786	.0789
SAT. D.O. CONC.	8.73	8.74	8.76	8.77	8.78	8.80	8.81	8.82
TEMPERATURE	20.56	20.49	20.41	20.34	20.26	20.19	20.11	20.04

TIME = 4.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.1113	.0399	.1154	.0395	.1127	.0467	.1415	.0466
SE COEFFICIENT	.0786	.0786	.0786	.0787	.0788	.0787	.0787	.0791
SAT. D.O. CONC.	8.80	8.81	8.82	8.83	8.85	8.86	8.87	8.88
TEMPERATURE	20.17	20.11	20.04	19.98	19.92	19.86	19.79	19.73

TIME = 6.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.1724	.0568	.1529	.0485	.1319	.0521	.1523	.0484
SE COEFFICIENT	.0785	.0785	.0785	.0786	.0787	.0787	.0786	.0790
SAT. D.O. CONC.	8.89	8.90	8.91	8.92	8.93	8.94	8.95	8.95
TEMPERATURE	19.68	19.63	19.57	19.52	19.48	19.42	19.38	19.32

DORM INPUT DATA FOR AUGUST 23, 1977

IN CHANNEL 5 FROM STATIONS 10 TO 18

```
       200.        0.01        720.        25.0        800.        0.41        24.5        2.00
       5.00        45.0        93.0        90.0        0.001       1.00        00.0        1.045
       00.0        600.        744.
    5.44E-4     3.80E-5     1.49E00
     8    13    12    20    10     1     3     0
   23.0 5.70 20.5 4.40 19.8 3.60 10.8 3.00 10.1
   11.9 6.80 11.9 7.50 11.8 6.60 12.1 6.10 11.3
    35.   16.    1.  351.  351.  351.  351.  351.  315.
   100.  100.  100.  100.  100.  100.  100.  100.  100.
    5.67E-4     5.67E-4     5.67E-4     5.67E-4     5.67E-4     5.67E-4     5.67E-4     5.67E-4
  CHANNEL 5 AUGUST 23  1977


    3.10  3.06  3.01  2.97  2.93  2.88  2.84  2.79  2.75
   19.2                                       18.8
   19.0                                       18.6
   19.0                                       18.6
   19.2                                       19.2
   20.7                                       19.7
   21.5                                       21.7
   21.8                                       22.0
   21.3                                       21.5
   20.7                                       20.6
   20.4                                       20.1
   20.0                                       19.7
   19.7                                       19.3
   19.3                                       19.1
   19.2                                       19.0
    2.5  2.5  2.0  3.0  3.5  3.7  3.0  2.7  2.0  1.7  1.5  1.5
    1.5
    45.   77.  360.  342.  361.  330.  361.   34.   34.   34  375.   27.
    27.
   3.10 4.00 6.35 9.3013.5015.0014.2010.90 7.40 6.20 5.40 5.10
   4.90
   5.12 7.12 9.1211.1213.1215.1217.1219.1221.1223.1225.1227.12
  29.12
   2.75 4.75 8.7013.4015.8016.1013.10 7.90 5.50 4.80 3.90 3.60
   7.21 9.2111.2113.2115.2117.2119.2121.2123.2125.2127.2129.21
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DORM SIMULATION PRINTOUT FOR AUGUST 23, 1977

IN CHANNEL 5 FROM STATIONS 10 TO 18

CHANNEL 5

ESTIMATION OF CHANNEL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES

BY NUMERICALLY ROUTING DIEL DISSOLVED OXYGEN MEASUREMENTS

BETWEEN TWO STATIONS

STARTING DATE =AUGUST 23 1977

LIST OF SYMBOLS:

C = D.O.CONCENTRATION G/M**3)
DSTAR = DIMENSIONLESS LONGITUDINAL DISPERSION NUMBER
EPS = COEFFICIENT WHICH SPECIFIES TIME STEP METHOD
(1.0 FOR FULLY IMPLICIT, 0.5 FOR CRANK-NICOLSON IMPLICIT)
P = PHOTOSYNTHETIC RATE OF CHANNEL REACH (G/(M*M*HR))
T = WATER TEMPERATURE (DEG. C)
TR = HYDRAULIC RESIDENCE TIME OF CHANNEL REACH (HR)

INPUT DATA

COMPUTATIONAL TIME INCREMENT = 720 SEC
COMPUTATIONAL DISTANCE INCREMENT = 7.6 M
EPS = 1.00
DSTAR = .01
MAXIMUM ERROR IN R OR P FOR ITERATION CONVERGENCE = .0010 G/(M*M*HR)
MAXIMUM ITERATIONS = 20
CONSTANT FOR ARRHENIUS RELATION = 1.045
CONSTANT REPRESENTATING RESPIRATION INHIBITION DUE TO LOW D. O. CONC. = 0 G/M**3
ORDER OF EQUATION FIT TO UPSTREAM D. O. MEASUREMENTS = 3

INPUT DATA FOR EACH SEGMENT

SEGMENT NUMBER	10	11	12	13	14	15	16	17	18
INITIAL D.O. AT UPSTREAM END OF SEGMENT (G/M**3)	3.10	3.06	3.01	2.97	2.93	2.88	2.84	2.79	2.75
SEGMENT LENGTH (M)	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
CROSS-SECT. AREA (M*M)	2.14	.53	1.90	.41	.94	.33	1.75	.28	
SURFACE WIDTH (M)	3.63	2.07	3.63	2.29	3.60	2.01	3.69	1.86	
SEGMENT DIRECTION (DEG)	35.	16.	1.	351.	351.	351.	351.	351.	
WATER SURFACE SLOPE	00057	00057	00057	00057	00057	00057	00057	00057	

WEATHER DATA INPUT TO MODEL

TIME	WIND VELOCITY (M/SEC)	WIND DIRECTION (DEGREES)	AIR PRESSURE (MB)
6.00	2.50	45.00	991.67
8.00	2.50	77.00	991.67
10.00	2.00	360.00	991.67
12.00	3.00	342.00	991.67
14.00	3.50	361.00	991.67
16.00	3.70	330.00	991.67
18.00	3.00	361.00	991.67
20.00	2.70	34.00	991.67
22.00	2.00	34.00	991.67
24.00	1.70	34.00	991.67
2.00	1.50	325.00	991.67
4.00	1.50	27.00	991.67
6.00	1.50	27.00	991.67

MEASURED DISSOLVED OXYGEN (G/M**3)

UPSTREAM TIME	UPSTREAM D.O.	DOWNSTREAM TIME	DOWNSTREAM D.O.
4.20	3.10	6.35	2.75
6.20	4.00	8.35	4.75
8.20	6.35	10.35	8.70
10.20	9.30	12.35	13.40
12.20	13.50	14.35	15.80
14.20	15.00	16.35	16.10
16.20	14.20	18.35	13.10
18.20	10.90	20.35	7.90
20.20	7.40	22.35	5.50
22.20	6.20	24.35	4.80
24.20	5.40	26.35	3.90
26.20	5.10	28.35	3.60
28.20	4.90	0	I

STANDARD RESPIRATION RATE = .4100 G/(M*M*HR) AT 20 DEG C   MEAN ERROR = -.0093   6 ITERATIONS

STANDARD RESPIRATION RATE = .4193 G/(M*M*HR) AT 20 DEG C   MEAN ERROR = -.0004   8 ITERATIONS

****

RESULTS OF COMPUTATIONS:

STANDARD RESPIRATORY RATE = .4193 G/(M*M*HR) AT 20 DEG C
SUNRISE TIME = 4.61
SUNSET TIME = 19.58
8 ITERATIONS

ROUTED TOTAL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES

TIME	P	R	RESIDUAL	TR
	----G/(M*M*HR)	----	G/M**3	HR
6.35	.143	.398	.000	2.062
8.35	.409	.398	-.000	2.062
10.35	.836	.406	.000	2.062
12.35	1.276	.423	.000	2.062
14.35	1.099	.446	.000	2.062
16.35	.894	.454	.000	2.062
18.35	.392	.446	-.000	2.062
20.35	0	.433	-.656	2.062
22.35	0	.424	-.154	2.062
.35	0	.417	.325	2.062
2.35	0	.411	.027	2.062
4.35	0	.381	-.203	2.062

DAY 1
TOTAL DAILY RESPIRATION = 10.0807G/M**2
TOTAL DAILY PHOTOSYNTHESIS = 10.1499G/M**2
P/R RATIO = 1.0068

COMPUTED VALUES OF SURFACE D. O. EXCHANGE (G/(M*M*HR)),
SURFACE EXCHANGE COEFFICIENT (/HR),
SATURATION D.O. CONCENTRATION (G/M**3),
AND WATER TEMPERATURE (DEG. C)
FOR EACH CHANNEL SEGMENT

SECTION NO.	10	11	12	13	14	15	16	17
TIME = 6.00 FLOW RATE = .0378 (M**3/SEC)								
SURFACE EXCH.	.2843	.1220	.2465	.0841	.2432	.0802	.2305	.0738
SE COEFFICIENT	.0856	.0830	.0803	.0789	.0789	.0789	.0789	.0789
SAT. D.O. CONC.	8.98	8.99	9.00	9.01	9.02	9.03	9.04	9.05
TEMPERATURE	19.18	19.12	19.07	19.02	18.98	18.92	18.88	18.82
TIME = 8.00 FLOW RATE = .0378 (M**3/SEC)								
SURFACE EXCH.	.2090	.0929	.1975	.0698	.2049	.0685	.1991	.0645
SE COEFFICIENT	.0806	.0784	.0780	.0780	.0780	.0780	.0780	.0780
SAT. D.O. CONC.	9.02	9.03	9.04	9.05	9.06	9.07	9.08	9.09
TEMPERATURE	18.98	18.92	18.88	18.82	18.77	18.73	18.68	18.62

TIME = 10.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0917	.0445	.0993	.0352	.1064	.0359	.1074	.0352
SE COEFFICIENT	.0795	.0810	.0815	.0813	.0813	.0813	.0813	.0813
SAT. D.O. CONC.	9.02	9.03	9.04	9.05	9.06	9.07	9.08	9.09
TEMPERATURE	18.98	18.92	18.88	18.82	18.77	18.73	18.68	18.62

TIME = 12.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.0739	-.0322	-.0636	-.0226	-.0607	-.0201	-.0539	-.0175
SE COEFFICIENT	.0803	.0858	.0898	.0914	.0914	.0914	.0914	.0914
SAT. D.O. CONC.	8.98	8.98	8.98	8.98	8.98	8.98	8.98	8.98
TEMPERATURE	19.20	19.20	19.20	19.20	19.20	19.20	19.20	19.20

TIME = 14.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.2478	-.1240	-.2548	-.0874	-.2467	-.0812	-.2284	-.0735
SE COEFFICIENT	.0904	.0967	.0983	.0976	.0977	.0977	.0977	.0977
SAT. D.O. CONC.	8.72	8.74	8.76	8.78	8.81	8.83	8.85	8.87
TEMPERATURE	20.64	20.51	20.39	20.26	20.14	20.01	19.89	19.76

TIME = 16.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.2927	-.1428	-.3225	-.1175	-.3387	-.1123	-.3218	-.1038
SE COEFFICIENT	.0796	.0866	.0937	.0975	.0975	.0975	.0975	.0975
SAT. D.O. CONC.	8.57	8.56	8.56	8.55	8.55	8.54	8.54	8.54
TEMPERATURE	21.51	21.54	21.56	21.59	21.61	21.64	21.66	21.69

TIME = 18.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.2420	-.1184	-.2584	-.0914	-.2697	-.0906	-.2647	-.0862
SE COEFFICIENT	.0858	.0903	.0916	.0910	.0910	.0910	.0910	.0910
SAT. D.O. CONC.	8.52	8.51	8.51	8.50	8.50	8.49	8.49	8.49
TEMPERATURE	21.81	21.84	21.86	21.89	21.91	21.94	21.96	21.99

TIME = 20.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.0744	-.0381	-.0870	-.0315	-.0993	-.0346	-.1065	-.0357
SE COEFFICIENT	.0881	.0867	.0837	.0815	.0815	.0815	.0815	.0815
SAT. D.O. CONC.	8.60	8.60	8.59	8.59	8.58	8.58	8.57	8.57
TEMPERATURE	21.31	21.34	21.36	21.39	21.41	21.44	21.46	21.49

TIME = 22.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0701	.0292	.0554	.0186	.0489	.0153	.0386	.0115
SE COEFFICIENT	.0816	.0810	.0799	.0792	.0792	.0792	.0792	.0792
SAT. D.O. CONC.	8.71	8.71	8.71	8.71	8.72	8.72	8.72	8.72
TEMPERATURE	30.68	30.68	30.67	30.66	30.64	30.63	30.62	30.61

TIME = 24.00 FLOW RATE = .0378 (M**3/SEC)								
SURFACE EXCH.	.1339	.0602	.1251	.0443	.1203	.0430	.1231	.0400
SE COEFFICIENT	.0800	.0796	.0791	.0787	.0787	.0787	.0787	.0787
SAT. D.O. CONC.	8.76	8.77	8.78	8.70	8.79	8.80	8.80	8.81
TEMPERATURE	20.38	20.34	20.31	20.27	20.23	20.19	20.16	20.12
TIME = 2.00 FLOW RATE = .0378 (M**3/SEC)								
SURFACE EXCH.	.1646	.0746	.1573	.0560	.1644	.0556	.1620	.0532
SE COEFFICIENT	.0709	.0792	.0791	.0788	.0788	.0788	.0708	.0788
SAT. D.O. CONC.	8.83	8.84	8.85	8.86	8.86	8.87	8.88	8.88
TEMPERATURE	19.98	19.94	19.91	19.87	19.83	19.79	19.76	19.72
TIME = 4.00 FLOW RATE = .0378 (M**3/SEC)								
SURFACE EXCH.	.1820	.0825	.1744	.0622	.1830	.0620	.1812	.0596
SE COEFFICIENT	.0791	.0720	.0787	.0785	.0785	.0785	.0785	.0785
SAT. D.O. CONC.	8.89	8.90	8.91	8.92	8.93	8.94	8.95	8.95
TEMPERATURE	19.68	19.63	19.57	19.52	19.48	19.42	19.38	19.32
TIME = 6.00 FLOW RATE = .0378 (M**3/SEC)								
SURFACE EXCH.	.1929	.0865	.1799	.0629	.1832	.0613	.1782	.0582
SE COEFFICIENT	.0790	.0790	.0787	.0784	.0784	.0784	.0784	.0784
SAT. D.O. CONC.	8.96	8.97	8.97	8.98	8.98	8.98	8.99	8.99
TEMPERATURE	19.29	19.26	19.24	19.21	19.19	19.16	19.14	19.11

DORM INPUT DATA FOR AUGUST 23, 1977

IN CHANNEL 8 FROM STATIONS 2 TO 10

```
     200.        0.01        720.        25.0        800.        0.39        24.5        2.00
     5.00        45.0        93.0        70.0        0.001       1.00        00.0        1.045
     00.0        600.        744.
  5.44E-4     3.80E-5     1.49E00
   8   13   17   20    2    1    3    0
 19.0 3.39 21.0 3.77 23.5 3.52 23.4 2.89 22.6
 11.0 6.40 10.4 6.60 11.6 6.20 12.3 5.70 11.3
  92.  92.  90.  80.  72.  69.  69.  58.  44.
 100. 100. 100. 100. 100. 100. 100. 100. 100.
  5.67E-4    5.67E-4    5.67E-4    5.67E-4    5.67E-4    5.67E-4    5.67E-4    5.67E-4
CHANNEL 8 AUGUST 23  1977


  6.90  6.63  6.36  6.09  5.83  5.56  5.29  5.02  4.75
 29.0                                        27.0
 28.6                                        26.6
 28.4                                        26.8
 28.8                                        27.2
 29.3                                        27.8
 30.0                                        28.2
 30.2                                        28.4
 30.6                                        28.8
 30.9                                        29.3
 30.8                                        29.2
 30.0                                        28.3
 28.7                                        26.1
 26.0                                        24.8
 25.6                                        25.2
  2.5  2.5  2.0  3.0  3.5  3.7  3.0  2.7  2.0  1.7  1.5  1.5
  1.5
  45.  77. 360. 342. 361. 330. 361.  34.  34.  34. 375.  27.
  27.
  6.90 6.75 7.10 8.00 8.80 9.70 9.90 9.50 8.70 7.70 7.30 7.00
  6.90
  5.03 7.03 9.0311.0313.0315.0317.0319.0321.0323.0325.0327.03
 29.03
  4.90 6.50 7.4510.2010.8010.70 8.40 6.30 5.20 4.90 4.70 4.60
  7.15 9.1511.1513.1515.1517.1519.1521.1523.1525.1527.1529.15
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DORM SIMULATION PRINTOUT FOR AUGUST 23, 1977

IN CHANNEL 8 FROM STATIONS 2 TO 10

CHANNEL 8

ESTIMATION OF CHANNEL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES

BY NUMERICALLY ROUTING DIEL DISSOLVED OXYGEN MEASUREMENTS

BETWEEN TWO STATIONS

STARTING DATE =AUGUST 23 1977

LIST OF SYMBOLS:

C = D.O.CONCENTRATION G/M**3)
DSTAR = DIMENSIONLESS LONGITUDINAL DISPERSION NUMBER
EPS = COEFFICIENT WHICH SPECIFIES TIME STEP METHOD
(1.0 FOR FULLY IMPLICIT, 0.5 FOR CRANK-NICOLSON IMPLICIT)
P = PHOTOSYNTHETIC RATE OF CHANNEL REACH (G/(M*M*HR))
T = WATER TEMPERATURE (DEG. C)
TR = HYDRAULIC RESIDENCE TIME OF CHANNEL REACH (HR)

INPUT DATA

COMPUTATIONAL TIME INCREMENT = 720. SEC
COMPUTATIONAL DISTANCE INCREMENT = 7.6 M
EPS = 1.00
DSTAR = .01
MAXIMUM ERROR IN R OR P FOR ITERATION CONVERGENCE = .0010 G/(M*M*HR)
MAXIMUM ITERATIONS = 20
CONSTANT FOR ARRHENIUS RELATION = 1.045
CONSTANT REPRESENTATING RESPIRATION INHIBITION DUE TO LOW D. O. CONC. = 0 G/M**3
ORDER OF EQUATION FIT TO UPSTREAM D. O. MEASUREMENTS = 3

INPUT DATA FOR EACH SEGMENT

SEGMENT NUMBER	2	3	4	5	6	7	8	9	10
INITIAL D.O. AT UPSTREAM END OF SEGMENT (G/M**3)	6.90	6.63	6.36	6.09	5.83	5.56	5.29	5.02	4.75
SEGMENT LENGTH (M)	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
CROSS-SECT. AREA (M*M)	1.77	.31	1.95	.35	2.18	.33	2.17	.27	
SURFACE WIDTH (M)	3.35	1.95	3.17	2.01	3.54	1.89	3.75	1.74	
SEGMENT DIRECTION (DEG)	92.	92.	90.	80.	72.	69.	69.	58.	
WATER SURFACE SLOPE	.00057	.00057	.00057	.00057	.00057	.00057	.00057	.00057	

WEATHER DATA INPUT TO MODEL

TIME	WIND VELOCITY (M/SEC)	WIND DIRECTION (DEGREES)	AIR PRESSURE (MB)
6.00	2.50	45.00	991.67
8.00	2.50	77.00	991.67
10.00	2.00	360.00	991.67
12.00	3.00	342.00	991.67
14.00	3.50	361.00	991.67
16.00	3.70	330.00	991.67
18.00	3.00	361.00	991.67
20.00	2.70	34.00	991.67
22.00	2.00	34.00	991.67
24.00	1.70	34.00	991.67
2.00	1.50	375.00	991.67
4.00	1.50	27.00	991.67
6.00	1.50	27.00	991.67

MEASURED DISSOLVED OXYGEN (G/M**3)

UPSTREAM		DOWNSTREAM	
TIME	D.O.	TIME	D.O.
4.05	6.90	6.25	4.90
6.05	6.75	8.25	6.50
8.05	7.10	10.25	7.45
10.05	8.00	12.25	10.20
12.05	8.80	14.25	10.80
14.05	9.70	16.25	10.70
16.05	9.90	18.25	8.40
18.05	9.50	20.25	6.30
20.05	8.70	22.25	5.20
22.05	7.70	24.25	4.90
24.05	7.30	26.25	4.70
26.05	7.00	28.25	4.60
28.05	6.90	0	I

STANDARD RESPIRATION RATE = .3900 G/(M*M*HR) AT 20 DEG C   MEAN ERROR = -.0215   6 ITERATIONS

STANDARD RESPIRATION RATE = .4115 G/(M*M*HR) AT 20 DEG C   MEAN ERROR = -.0007   9 ITERATIONS

****

RESULTS OF COMPUTATIONS:

STANDARD RESPIRATORY RATE = .4115 G/(M*M*HR) AT 20 DEG C
SUNRISE TIME = 4.61
SUNSET TIME = 19.58
9 ITERATIONS

ROUTED TOTAL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES

TIME	P	R	RESIDUAL	TR
	----G/(M*M*HR)----		G/M**3	HR
6.25	.135	.577	.000	2.096
8.25	.540	.575	-.000	2.096
10.25	.650	.583	.000	2.096
12.25	1.145	.597	.000	2.096
14.25	1.054	.611	-.000	2.096
16.25	.888	.619	.000	2.096
18.25	.322	.628	-.000	2.096
20.25	0	.639	-.022	2.096
22.25	0	.638	-.235	2.096
.25	0	.617	.149	2.096
2.25	.0	.576	.151	2.096
4.25	0	.511	-.090	2.096

DAY 1
TOTAL DAILY RESPIRATION = 14.3600G/M**2
TOTAL DAILY PHOTOSYNTHESIS = 9.5181G/M**2
P/R RATIO = .6628

COMPUTED VALUES OF SURFACE D. O. EXCHANGE (G/(M*M*HR)),
SURFACE EXCHANGE COEFFICIENT (/HR),
SATURATION D.O. CONCENTRATION (G/M**3),
AND WATER TEMPERATURE (DEG. C)
FOR EACH CHANNEL SEGMENT

SECTION NO.	2	3	4	5	6	7	8	9
TIME = 6.00 FLOW RATE = .0378 (M**3/SEC)								
SURFACE EXCH.	.0300	.0126	.0593	.0213	.0875	.0283	.1048	.0316
SE COEFFICIENT	.0780	.0779	.0781	.0792	.0803	.0806	.0806	.0817
SAT. D.O. CONC.	7.44	7.47	7.51	7.54	7.58	7.61	7.65	7.69
TEMPERATURE	28.88	28.62	28.37	28.13	27.87	27.63	27.37	27.13

TIME = 8.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0296	.0121	.0541	.0183	.0726	.0232	.0859	.0254
SE COEFFICIENT	.0816	.0816	.0818	.0822	.0822	.0821	.0821	.0811
SAT. D.O. CONC.	7.49	7.53	7.56	7.60	7.64	7.67	7.71	7.74
TEMPERATURE	28.48	28.22	27.97	27.73	27.48	27.23	26.98	26.73

TIME = 10.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0047	.0027	.0149	.0054	.0237	.0079	.0315	.0097
SE COEFFICIENT	.0768	.0768	.0767	.0767	.0766	.0766	.0766	.0766
SAT. D.O. CONC.	7.52	7.55	7.57	7.60	7.63	7.66	7.69	7.72
TEMPERATURE	28.30	28.10	27.90	27.70	27.50	27.30	27.10	26.90

TIME = 12.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.0339	-.0112	-.0429	-.0130	-.0457	-.0134	-.0432	-.0117
SE COEFFICIENT	.0770	.0770	.0769	.0768	.0767	.0767	.0766	.0766
SAT. D.O. CONC.	7.46	7.49	7.52	7.55	7.57	7.60	7.63	7.66
TEMPERATURE	28.70	28.50	28.30	28.10	27.90	27.70	27.50	27.30

TIME = 14.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.0737	-.0250	-.0991	-.0304	-.1115	-.0335	-.1146	-.0330
SE COEFFICIENT	.0770	.0770	.0769	.0769	.0770	.0771	.0771	.0785
SAT. D.O. CONC.	7.39	7.42	7.44	7.47	7.50	7.52	7.55	7.58
TEMPERATURE	29.21	29.02	28.83	28.64	28.46	28.27	28.08	27.89

TIME = 16.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.1040	-.0334	-.1279	-.0370	-.1324	-.0387	-.1325	-.0371
SE COEFFICIENT	.0791	.0791	.0786	.0773	.0770	.0769	.0769	.0768
SAT. D.O. CONC.	7.30	7.33	7.36	7.39	7.42	7.45	7.48	7.52
TEMPERATURE	29.89	29.66	29.44	29.21	28.99	28.76	28.54	28.31

TIME = 18.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.0998	-.0296	-.1091	-.0298	-.1027	-.0282	-.0941	-.0255
SE COEFFICIENT	.0772	.0772	.0771	.0771	.0771	.0771	.0771	.0777
SAT. D.O. CONC.	7.27	7.30	7.33	7.36	7.39	7.42	7.46	7.49
TEMPERATURE	30.09	29.86	29.64	29.41	29.19	28.96	28.74	28.51

TIME = 20.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.0767	-.0192	-.0621	-.0134	-.0377	-.0068	-.0164	-.0019
SE COEFFICIENT	.0777	.0777	.0778	.0787	.0788	.0803	.0803	.0821
SAT. D.O. CONC.	7.21	7.24	7.27	7.31	7.34	7.37	7.40	7.43
TEMPERATURE	30.49	30.26	30.04	29.81	29.59	29.36	29.14	28.91

TIME = 22.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.0412	-.0074	-.0150	.0007	.0149	.0092	.0411	.0152
SE COEFFICIENT	.0775	.0774	.0774	.0776	.0779	.0780	.0779	.0785
SAT. D.O. CONC.	7.17	7.20	7.23	7.25	7.28	7.31	7.34	7.36
TEMPERATURE	30.80	30.60	30.40	30.20	30.00	29.80	29.60	29.40

TIME = 24.00 FLOW RATE = .0370 (M**3/SEC)

SURFACE EXCH.	-.0101	.0022	.0212	.0112	.0525	.0198	.0776	.0252
SE COEFFICIENT	.0774	.0774	.0773	.0774	.0775	.0775	.0775	.0777
SAT. D.O. CONC.	7.18	7.21	7.24	7.27	7.29	7.32	7.35	7.38
TEMPERATURE	30.70	30.50	30.30	30.10	29.90	29.70	29.50	29.30

TIME = 2.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0107	.0087	.0469	.0187	.0796	.0275	.1040	.0323
SE COEFFICIENT	.0772	.0771	.0771	.0770	.0770	.0770	.0769	.0770
SAT. D.O. CONC.	7.29	7.32	7.35	7.38	7.41	7.44	7.47	7.50
TEMPERATURE	29.89	29.68	29.47	29.26	29.04	28.83	28.62	28.41

TIME = 4.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0268	.0135	.0651	.0237	.0981	.0328	.1226	.0374
SE COEFFICIENT	.0769	.0768	.0767	.0767	.0767	.0766	.0766	.0767
SAT. D.O. CONC.	7.48	7.53	7.58	7.62	7.67	7.72	7.76	7.81
TEMPERATURE	28.54	28.21	27.89	27.56	27.24	26.91	26.59	26.26

TIME = 6.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0429	.0173	.0743	.0244	.0958	.0305	.1116	.0333
SE COEFFICIENT	.0763	.0763	.0762	.0762	.0763	.0763	.0762	.0764
SAT. D.O. CONC.	7.86	7.89	7.91	7.93	7.95	7.98	8.00	8.02
TEMPERATURE	25.92	25.77	25.62	25.47	25.33	25.17	25.02	24.87

DORM INPUT DATA FOR AUGUST 23, 1977

IN CHANNEL 8 FROM STATIONS 10 TO 18

```
       200.       0.01       720.       25.0       800.       0.80       24.5       2.00
       5.00       45.0       93.0       90.0       0.001      1.00       0.00       1.045
       00.0       600.       744.
    5.44E-4    3.80E-5    1.49E00
     8   13   12   20   10    1    3    0
   21.6 3.11 20.6 2.16 18.9 4.07 23.5 2.16 18.4
   11.3 5.80 10.4 5.60 11.0 6.20 11.3 6.00 10.9
   44.  29.  15.   5. 350. 350. 350. 350. 350.
   100. 100. 100. 100. 100. 100. 100. 100. 100.
    5.67E-4    5.67E-4    5.67E-4    5.67E-4    5.67E-4    5.67E-4    5.67E-4    5.67E-4
  CHANNEL 8 AUGUST 23  1977


   4.75  4.54  4.34  4.13  3.93  3.72  3.51  3.31  3.10
  27.0                                 26.3
  26.6                                 26.1
  26.8                                 26.3
  27.2                                 26.6
  27.8                                 27.0
  28.2                                 27.6
  28.4                                 27.6
  28.8                                 28.2
  29.3                                 28.6
  29.2                                 28.6
  28.3                                 27.2
  26.1                                 26.2
  24.8                                 26.9
  25.2                                 26.8
   2.5  2.5  2.0  3.0  3.5  3.7  3.0  2.7  2.0  1.7  1.5  1.5
   1.5
   45.  77. 360. 342. 361. 330. 361.  34.  34.  34. 375.  27.
   27.
   4.75 4.90 6.50 7.4510.2010.8010.70 8.40 6.30 5.20 4.90 4.70
   4.60
   5.15 7.15 9.1511.1513.1515.1517.1519.1521.1523.1525.1527.15
  29.15
   3.25 5.95 8.6513.2013.4012.00 8.70 4.50 3.30 3.00 2.60 2.50
   7.21 9.2411.2413.2415.2417.2419.2421.2423.2425.2427.2429.24
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DORM SIMULATION PRINTOUT FOR AUGUST 23, 1977

IN CHANNEL 8 FROM STATIONS 10 TO 18

CHANNEL 8

ESTIMATION OF CHANNEL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES

BY NUMERICALLY ROUTING DIEL DISSOLVED OXYGEN MEASUREMENTS

BETWEEN TWO STATIONS

STARTING DATE =AUGUST 23 1977

LIST OF SYMBOLS:

C = D.O.CONCENTRATION G/M**3)
DSTAR = DIMENSIONLESS LONGITUDINAL DISPERSION NUMBER
FPS = COEFFICIENT WHICH SPECIFIES TIME STEP METHOD
(1.0 FOR FULLY IMPLICIT, 0.5 FOR CRANK-NICOLSON IMPLICIT)
P = PHOTOSYNTHETIC RATE OF CHANNEL REACH (G/(M*M*HR))
T = WATER TEMPERATURE (DEG. C)
TR = HYDRAULIC RESIDENCE TIME OF CHANNEL REACH (HR)

INPUT DATA

COMPUTATIONAL TIME INCREMENT = 720. SEC
COMPUTATIONAL DISTANCE INCREMENT = 7.6 M
EPS = 1.00
DSTAR = .01
MAXIMUM ERROR IN R OR P FOR ITERATION CONVERGENCE = .0010 G/(M*M*HR)
MAXIMUM ITERATIONS = 20
CONSTANT FOR ARRHENIUS RELATION = 1.045
CONSTANT REPRESENTATING RESPIRATION INHIBITION DUE TO LOW D. O. CONC. = 0 G/M**3
ORDER OF EQUATION FIT TO UPSTREAM D. O. MEASUREMENTS = 3

INPUT DATA FOR EACH SEGMENT

SEGMENT NUMBER	10	11	12	13	14	15	16	17	18
INITIAL D.O. AT UPSTREAM END OF SEGMENT (G/M**3)	4.75	4.54	4.34	4.13	3.93	3.72	3.51	3.31	3.10
SEGMENT LENGTH (M)	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
CROSS-SECT. AREA (M*M)	2.01	.29	1.91	.20	1.76	.38	2.18	.20	
SURFACE WIDTH (M)	3.44	1.77	3.17	1.71	3.35	1.89	3.44	1.83	
SEGMENT DIRECTION (DEG)	44.	29.	15.	5.	350.	350.	350.	350.	
WATER SURFACE SLOPE	.00057	.00057	.00057	.00057	.00057	.00057	.00057	.00057	

WEATHER DATA INPUT TO MODEL

TIME	WIND VELOCITY (M/SEC)	WIND DIRECTION (DEGREES)	AIR PRESSURE (MB)
6.00	2.50	45.00	991.67
8.00	2.50	77.00	991.67
10.00	2.00	360.00	991.67
12.00	3.00	342.00	991.67
14.00	3.50	361.00	991.67
16.00	3.70	330.00	991.67
18.00	3.00	361.00	991.67
20.00	2.70	34.00	991.67
22.00	2.00	34.00	991.67
24.00	1.70	34.00	991.67
2.00	1.50	375.00	991.67
4.00	1.50	27.00	991.67
6.00	1.50	27.00	991.67

MEASURED DISSOLVED OXYGEN (G/M**3)

UPSTREAM TIME	UPSTREAM D.O.	DOWNSTREAM TIME	DOWNSTREAM D.O.
4.25	4.75	6.35	3.25
6.25	4.90	8.40	5.95
8.25	6.50	10.40	8.65
10.25	7.45	12.40	13.20
12.25	10.20	14.40	13.40
14.25	10.80	16.40	12.00
16.25	10.70	18.40	8.70
18.25	8.40	20.40	4.50
20.25	6.30	22.40	3.30
22.25	5.20	24.40	3.00
24.25	4.90	26.40	2.60
26.25	4.70	28.40	2.50
28.25	4.60	0	I

STANDARD RESPIRATION RATE = .8000 G/(M*M*HR) AT 20 DEG C   MEAN ERROR = .3557   6 ITERATIONS

STANDARD RESPIRATION RATE = .4443 G/(M*M*HR) AT 20 DEG C   MEAN ERROR = .0118   10 ITERATIONS

STANDARD RESPIRATION RATE = .4325 G/(M*M*HR) AT 20 DEG C   MEAN ERROR = .0002   12 ITERATIONS

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RESULTS OF COMPUTATIONS

STANDARD RESPIRATORY RATE = .4325 G/(M*M*HR) AT 20 DEG C
SUNRISE TIME = 4.61
SUNSET TIME = 19.58
12 ITERATIONS

ROUTED TOTAL COMMUNITY PHOTOSYNTHETIC AND RESPIRATORY RATES

TIME	P	R	RESIDUAL	TR
	----G/(M*M*HR)----		G/M**3	HR
6.35	.177	.574	-.000	2.003
8.40	.748	.577	.000	2.003
10.40	1.051	.586	-.000	2.003
12.40	1.839	.598	-.000	2.003
14.40	1.358	.610	-.000	2.003
16.40	.923	.616	-.000	2.003
18.40	.278	.628	-.000	2.003
20.40	0	.639	-.865	2.003
22.40	0	.637	-.172	2.003
.40	0	.609	.353	2.003
2.40	0	.572	.098	2.003
4.40	0	.518	-.263	2.003

DAY 1
TOTAL DAILY RESPIRATION = 14.3493G/M**2
TOTAL DAILY PHOTOSYNTHESIS = 12.8469G/M**2
P/R RATIO = .8953

COMPUTED VALUES OF SURFACE D. O. EXCHANGE (G/(M*M*HR)),
SURFACE EXCHANGE COEFFICIENT (/HR),
SATURATION D.O. CONCENTRATION (G/M**3),
AND WATER TEMPERATURE (DEG. C)
FOR EACH CHANNEL SEGMENT

SECTION NO.	10	11	12	13	14	15	16	17
TIME = 6.00 FLOW RATE = .0378 (M**3/SEC)								
SURFACE EXCH.	.1470	.0436	.1652	.0338	.1538	.0615	.2018	.0367
SE COEFFICIENT	.0825	.0817	.0800	.0786	.0771	.0771	.0771	.0771
SAT. D.O. CONC.	7.71	7.72	7.74	7.75	7.76	7.77	7.79	7.80
TEMPERATURE	26.96	26.87	26.78	26.69	26.61	26.52	26.43	26.34
TIME = 8.00 FLOW RATE = .0378 (M**3/SEC)								
SURFACE EXCH.	.1124	.0329	.1255	.0256	.1181	.0471	.1558	.0284
SE COEFFICIENT	.0795	.0777	.0768	.0766	.0766	.0765	.0765	.0765
SAT. D.O. CONC.	7.77	7.78	7.79	7.80	7.80	7.81	7.82	7.83
TEMPERATURE	26.57	26.51	26.44	26.38	26.32	26.26	26.19	26.13

TIME = 10.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0495	.0130	.0477	.0084	.0367	.0135	.0469	.0081
SE COEFFICIENT	.0772	.0779	.0787	.0790	.0788	.0788	.0788	.0788
SAT. D.O. CONC.	7.74	7.75	7.76	7.77	7.77	7.78	7.79	7.80
TEMPERATURE	26.77	26.71	26.64	26.58	26.52	26.46	26.39	26.33

TIME = 12.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.0356	-.0149	-.0657	-.0170	-.0858	-.0375	-.1213	-.0238
SE COEFFICIENT	.0772	.0793	.0826	.0848	.0870	.0871	.0871	.0871
SAT. D.O. CONC.	7.68	7.69	7.70	7.71	7.72	7.74	7.75	7.76
TEMPERATURE	27.16	27.09	27.01	26.94	26.86	26.79	26.71	26.64

TIME = 14.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.1316	-.0457	-.1869	-.0419	-.1962	-.0816	-.2666	-.0508
SE COEFFICIENT	.0829	.0882	.0918	.0930	.0923	.0923	.0923	.0923
SAT. D.O. CONC.	7.60	7.61	7.62	7.64	7.65	7.67	7.68	7.70
TEMPERATURE	27.75	27.65	27.55	27.45	27.35	27.25	27.15	27.05

TIME = 16.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.1520	-.0472	-.1916	-.0419	-.2049	-.0827	-.2718	-.0507
SE COEFFICIENT	.0771	.0707	.0834	.0876	.0927	.0927	.0928	.0928
SAT. D.O. CONC.	7.54	7.55	7.56	7.57	7.58	7.59	7.60	7.61
TEMPERATURE	28.16	28.09	28.01	27.94	27.86	27.79	27.71	27.64

TIME = 18.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.1164	-.0351	-.1367	-.0273	-.1233	-.0483	-.1600	-.0290
SE COEFFICIENT	.0803	.0838	.0863	.0872	.0867	.0867	.0867	.0867
SAT. D.O. CONC.	7.51	7.52	7.54	7.55	7.57	7.58	7.60	7.61
TEMPERATURE	28.35	28.25	28.15	28.05	27.95	27.85	27.75	27.65

TIME = 20.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	-.0213	-.0045	-.0163	-.0018	-.0067	-.0015	-.0090	-.0010
SE COEFFICIENT	.0839	.0842	.0830	.0814	.0790	.0789	.0789	.0789
SAT. D.O. CONC.	7.45	7.46	7.47	7.48	7.49	7.51	7.52	7.53
TEMPERATURE	28.76	28.69	28.61	28.54	28.46	28.39	28.31	28.24

TIME = 22.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.0639	.0214	.0834	.0186	.0864	.0358	.1135	.0214
SE COEFFICIENT	.0792	.0793	.0789	.0783	.0776	.0776	.0776	.0776
SAT. D.O. CONC.	7.38	7.40	7.41	7.42	7.43	7.44	7.46	7.47
TEMPERATURE	29.26	29.17	29.08	28.99	28.91	28.82	28.73	28.64

TIME = 24.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.1069	.0344	.1355	.0294	.1379	.0567	.1856	.0348
SE COEFFICIENT	.0782	.0782	.0780	.0777	.0773	.0773	.0773	.0773
SAT. D.O. CONC.	7.40	7.41	7.42	7.43	7.44	7.45	7.46	7.47
TEMPERATURE	29.16	29.09	29.01	28.94	28.86	28.79	28.71	28.64

TIME = 2.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.1266	.0403	.1595	.0345	.1623	.0669	.2215	.0416
SE COEFFICIENT	.0773	.0775	.0775	.0775	.0772	.0772	.0772	.0772
SAT. D.O. CONC.	7.53	7.55	7.57	7.59	7.61	7.63	7.65	7.67
TEMPERATURE	28.23	28.09	27.96	27.82	27.68	27.54	27.41	27.27

TIME = 4.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE EXCH.	.1467	.0453	.1762	.0374	.1742	.0711	.2350	.0439
SE COEFFICIENT	.0770	.0772	.0771	.0770	.0767	.0767	.0767	.0767
SAT. D.O. CONC.	7.84	7.83	7.83	7.83	7.83	7.83	7.82	7.82
TEMPERATURE	26.11	26.12	26.13	26.14	26.16	26.17	26.18	26.19

TIME = 6.00 FLOW RATE = .0378 (M**3/SEC)

SURFACE FXCH.	.1575	.0471	.1770	.0360	.1634	.0649	.2109	.0386
SE COEFFICIENT	.0768	.0770	.0770	.0769	.0767	.0768	.0768	.0769
SAT. D.O. CONC.	8.01	7.97	7.93	7.89	7.85	7.82	7.78	7.74
TEMPFRATURE	24.93	25.19	25.46	25.72	25.98	26.24	26.51	26.77